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Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report - Phase II

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

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R. G. Bauer
Fluor Hanford

Date Published
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EXECUTIVE SUMMARY

This document is the terrestrial ecological data quality objectives (EcoDQO) Phase II summary report for the Central Plateau on the Hanford Site. The document is the second in a series of three summary reports (Phases I, II, and III) for assessing ecological risks on the Central Plateau. This document evaluates the need for acquisition of soil and biota data in support of waste site decision-making and information on the health or condition of the ecosystem across the range of Central Plateau habitats. Steps 3 and 4 of EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*, are included and represent the data quality objectives (DQO) process for ecological risk assessments. Much of the EPA/540/R-97/006 Step 3 and Step 4 information provided in this document is germane to Phases I, II, and III of this project. The list of contaminants and the resulting analytical suites are expected to differ from one investigation phase to another. The culmination of the phased DQOs/sampling and analysis plans and field characterization activities will be a final Central Plateau ecological risk assessment, planned for fiscal year 2007, as shown in Figure ES-1.

The *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) established a framework to ensure that environmental impacts associated with past and present activities at the Hanford Site are investigated and that appropriate response actions are taken to protect human health and the environment. Within this framework, the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study process is implemented to gather the information needed to arrive at records of decision that authorize remedial actions. The ecological risk assessment supported by this DQO is one of several being performed on the Hanford Site to ensure that ecological risks have been properly evaluated in support of remedial action decision making. This document only addresses potential terrestrial ecological impacts on the Central Plateau. It does not address Central Plateau human health or groundwater impacts, nor does it consider ecological impacts in other portions of the Hanford Site.

The Central Plateau EcoDQO is being implemented using a phased and tiered approach to characterize ecological risks. Phases are based on spatial domains where investigation areas will be located; tiers are types of data collected within those investigation areas. Phase I activities were focused on the CERCLA waste sites in the 200 East and 200 West Areas. Phase II evaluates the need for ecological sampling in the US Ecology site, tank farms, the BC Controlled Area, and West Lake. Phase III is planned to evaluate the need for ecological sampling in habitat (non-operational) areas outside of the 200 East and 200 West Areas. Because of budgetary and schedule limitations that constrained the fiscal year 2004 activities, the spatial components of Phases I and II of the EcoDQO were characterized concurrently in fiscal year 2005.

The BC Controlled Area is the largest waste site evaluated in the Phase II EcoDQO. This unplanned release waste site was contaminated with wastes from the BC Cribs and Trenches Area, which received wastes primarily from the Uranium Recovery Project and secondarily from 300 Area wastes (WMP-18647, *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*). Because the BC Cribs and Trenches are part of a remedial investigation (DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)* and have been recommended for cleanup in response to human health risks, the ecological evaluation focuses on the BC Controlled Area. The BC Controlled Area has lower contaminant concentrations, but in the surface soils and over a larger area than the BC Cribs and Trenches.

The US Ecology site is a commercial low-level radioactive waste disposal site within the Hanford Site boundaries. It is a licensed state facility and is not operated or regulated by the U.S. Department of Energy. Thus, the US Ecology site is not a CERCLA waste site, although it is operated on Federal land being leased to the State of Washington. The site has been in operation since 1965 and consists of containerized solid wastes that are buried under a cover of deep fill. The site contains radionuclides and a limited set of nonradioactive constituents. Because the US Ecology site is not a Central Plateau CERCLA waste site, ecological data collected from the US Ecology site will not be used to support Central Plateau operational area decision making. Remedial actions are based on closure plans already under way that include capping the low-level radioactive waste trenches. Furthermore, the US Ecology site will remain operational for another 50 years (until 2056). The site is scheduled for closure when the lease expires in September 2063, which seems to further limit the utility of sampling current conditions at US Ecology; consequently, sampling is not planned for the US Ecology site in Phase II. It is recognized, however, that US Ecology-related contaminants may influence surrounding habitat in the Central Plateau. Consequently, existing air monitoring data for the US Ecology site (e.g., air monitoring data from Washington State Department of Health, Pacific Northwest National Laboratory monitoring data, other sources) will be compiled and evaluated. Such information will help determine if land adjacent to the US Ecology site should be considered in the possible assessment of the Central Plateau habitat areas in Phase III.

The tank farms are actively managed by the U.S. Department of Energy, Office of River Protection, using herbicides, pesticides, and physical barriers to prevent biological intrusion. Furthermore, little attractive habitat exists for biotic use. Every effort is made to capture biological intruders, and the captured animals are disposed of. Tank farm sites are being evaluated using the *Resource Conservation and Recovery Act of 1976* corrective action process, and the resulting remedies almost certainly will change the quality of ecological habitat within the tank farms. The tank farms also are subject to interim stabilization methods that include removing liquids from the tanks and sampling the waste. Until all interim tank remediation is finished, final remedial alternatives will not be evaluated. For these reasons, tank farm sites are not appropriate for ecological sampling at this time.

Although West Lake existed before the Hanford Site, West Lake's former expanse was largely a result of Plutonium-Uranium Extraction Plant and B Plant wastewater discharge that elevated the water table. Contaminated media included soil, water, and sediment. Surface water was identified as the only medium of concern by a screening-level ecological risk assessment. Because subsurface discharge has been discontinued in the 200 Areas, the lake has been shrinking in size. The aerial footprint of the lake has been observed to be as small as 3 m^2 or as large as hundreds of square meters. Thus, West Lake is dynamic and responds to climatological and seasonal conditions such as snow melt or large rain events. Because West Lake represents a unique and changing ecological feature at the Hanford Site, further data compilation is recommended before Phase III is begun so that all existing information can be evaluated and the data gaps can be defined. Additional ecological characterization will be coordinated with the potential remedial alternatives for West Lake and the associated groundwater operable units.

Consequently, West Lake will not be sampled in Phase II; the existing data quality objectives for West Lake will be revised as part of Phase III planning activities.

Contamination in the BC Controlled Area is thought to have originated from animal intrusion into the salt-laden wastes in BC Cribs and Trenches. The area has high-quality ecological habitat, and there are no active operations or plans for remedial actions that would change the quality of this habitat. Thus, the BC Controlled Area was considered to be appropriate for sampling in Phase II. The only radionuclide contaminants of potential ecological concern (COPEC) identified, based on samples collected in the BC Controlled Area, are Cs-137 and Sr-90. These COPECs also are primary radionuclide risk drivers in the Phase I 200 Areas waste sites (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*).

The BC Controlled Area COPECs were determined through a characterization activity that analyzed the radiologically contaminated soils for metals, total uranium, anions, and total polychlorinated biphenyls under the 200-UR-1 OU remedial investigation (D&D-24693, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*). Samples were collected from the most highly contaminated locations and from moderately contaminated locations in the BC Controlled Area; sixteen samples were collected in all. The data were compared to *Washington Administrative Code* soil screening values (WAC 173-340-900, "Tables," Table 749-3) and Hanford Site background soil concentrations (90th percentile values from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*). The results show that no nonradionuclide COPECs were identified to exceed the criteria; thus no nonradionuclide COPECS are recommended for Phase II analysis. Details of the data analysis are presented in Chapter 3.0 and Appendix B of this report.

Given the similarity of radionuclide COPECs between Phase I and Phase II and the similarity of the BC Controlled Area to habitat in and around the Central Plateau waste sites, the conceptual model, risk questions, assessment endpoints, measures, and study design developed in Phase I (WMP-20570) will be used for this Phase II EcoDQO. This information is summarized below.

Assessment endpoints were developed that are representative of terrestrial ecological receptors potentially at risk from COPECs in soil. Plants and soil macroinvertebrates are valuable assessment endpoint entities because, considering the lack of inorganic trophic transfer, they are potentially more exposed indicators for evaluating the adverse effects of inorganic COPECs. Central Plateau-specific receptors are suggested as ecological and societal relevant assessment endpoints that also address management goals. Central Plateau-specific receptors also are suggested as surrogates for the *Washington Administrative Code* feeding guilds, because they are at greater risk from COPECs in the toxicity evaluation. These feeding guilds include producers, soil biota, soil macroinvertebrates, middle-trophic-level vertebrates, and carnivorous reptiles, birds, and mammals. Some of these species will be selected for direct measures of exposure, effect, and ecosystem/receptor characteristics. Others species will be evaluated based on surrogates.

Risk questions were a logical outcome of COPEC refinement and consideration of assessment endpoint attributes, and they represent the conceptual model of how contaminant stressors are most likely to impact the Central Plateau ecosystem. Risk questions are posed to identify measures of effect, exposure, and ecosystem/receptor characteristics. Eight risk questions were developed, including the following:

1. Do COPECs in shallow zone soils decrease plant survival or growth?
2. Do COPECs in shallow zone soils affect decomposition by soil biota?
3. Do COPECs in shallow zone soils affect soil macroinvertebrate survival or growth?
4. Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous bird survival, growth, reproduction, or abundance or affect balanced gender ratios?
5. Do COPECs in shallow zone soils and food decrease insectivorous reptile abundance or biomass or affect size structure?
6. Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous mammal survival, growth, reproduction, abundance, or biomass or affect balanced gender ratios?

7. Do COPECs in shallow zone soils and food decrease carnivorous bird survival, growth, or reproduction?

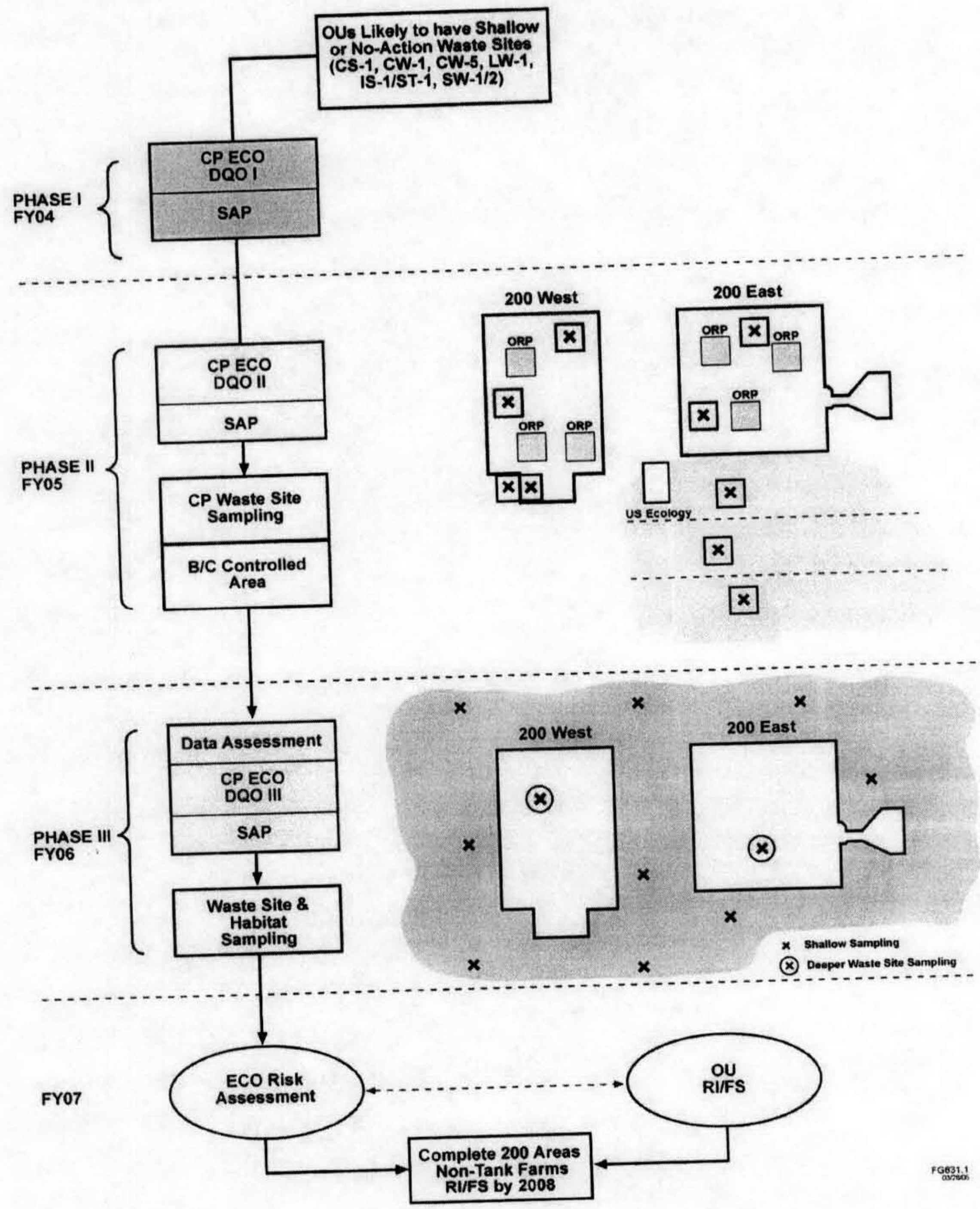
8. Do COPECs in shallow zone soils and food decrease carnivorous mammal survival, growth, or reproduction?

Measures of effect, exposure, and receptor/ecosystem characteristics were selected. These measures form the basis of the data needs for the study design. Measures of exposure include COPEC concentrations in soil and biota. Measures of effect include laboratory toxicity testing, comparison of COPEC concentrations in soil to literature-derived adverse-effect levels for plants and invertebrates in soil, modeled extrapolation of COPEC concentrations in soil to literature-derived adverse-effect levels for diet (wildlife only), comparison of COPEC concentrations in tissue to literature-derived adverse-effect levels for assessment endpoint tissue concentration (wildlife only), and field study of the potential for adverse effects (conditional on field verification efforts). Ecosystem/receptor characteristics are identified by various Central Plateau habitat types.

A sampling design is provided in Chapter 9.0, which shows how the various data types (measures) relate to risk questions, the key features of the study design, and the basis for the design element. All aspects of the study design are subject to field verification, which may require selecting alternate measures for an assessment endpoint or other modifications to the study design (e.g., plot size, trapping density). An important component of the conceptual model is the primary exposure medium, including the depth of biological activity. Data suggest that surface soil is important as an exposure medium for direct contact with wildlife, root uptake, and animal burrowing. The conceptual model and sample results for contamination in the BC Controlled Area also suggest that there will be concentrations of radionuclides in the upper part of the soil column. Thus, surface samples (of the first 15 cm [6 in.]) can be collected along with specific biological samples to test for COPEC uptake. Collecting surface soil samples initially has important practical advantages. Methods for collecting surface soil samples are less intrusive than those needed for deeper soil characterization (e.g., truck-mounted drill rigs) and therefore minimize the impacts of data collection on the shrub-steppe ecosystem. The conceptual model of possible mobility of subsurface contamination through animal burrowing and plant uptake also will be initially assessed using radiological field-data collection. Soils interrogated by the field data will be biased toward areas with a high potential for mobilized subsurface waste (i.e., mammal burrow spoils and ant mounds).

The specific receptors targeted for initial sampling are mammals, lizards, and soil macroinvertebrates, because these organisms were viewed as having a high potential to accumulate site COPECs. Plant tissue initially will be assessed for radionuclide uptake using radiological field data for gamma-emitting radionuclides. To help address trustee information needs, abnormalities will be noted for the animals handled during data collection. Additional data collection is dependent on the results of the initial investigation phases and may include characterization of soils deeper than 15 cm (6 in.), plant tissue concentrations, population measures for mammals and lizards, field verification for middle trophic-level birds, litterbag studies, and toxicity tests for plants and invertebrates.

Figure ES-1. Phased Central Plateau Ecological Risk Assessment.



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TERMS

AE	assessment endpoint
AUF	area-use factor
BCG	biota concentration guideline
BIV	bioaccumulation factor
BV	background value
CERCLA	*Comprehensive Environmental Response, Compensation and Liability Act of 1980*
COPEC	contaminant of potential ecological concern
DDT	dichloro-diphenyl-trichloroethane
DQA	data quality assessment
DQO	data quality objective
EcoDQO	ecological data quality objective
ERA	ecological risk assessment
ERAGS	EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*
FD	frequency of detects
GEA	gamma energy analysis
GPC	gas proportional counter
NA	not applicable
OU	operable unit
PCB	polychlorinated biphenyl
RQ	risk question
SAP	sampling and analysis plan
SOF	sum of fractions
SSV	soil-screening value
TBD	to be determined
TEE	terrestrial ecological evaluation
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRV	toxicity reference value
WAC	*Washington Administrative Code*

1.0 OVERVIEW: ECOLOGICAL RISK ASSESSMENT GUIDANCE FOR THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT OF 1980

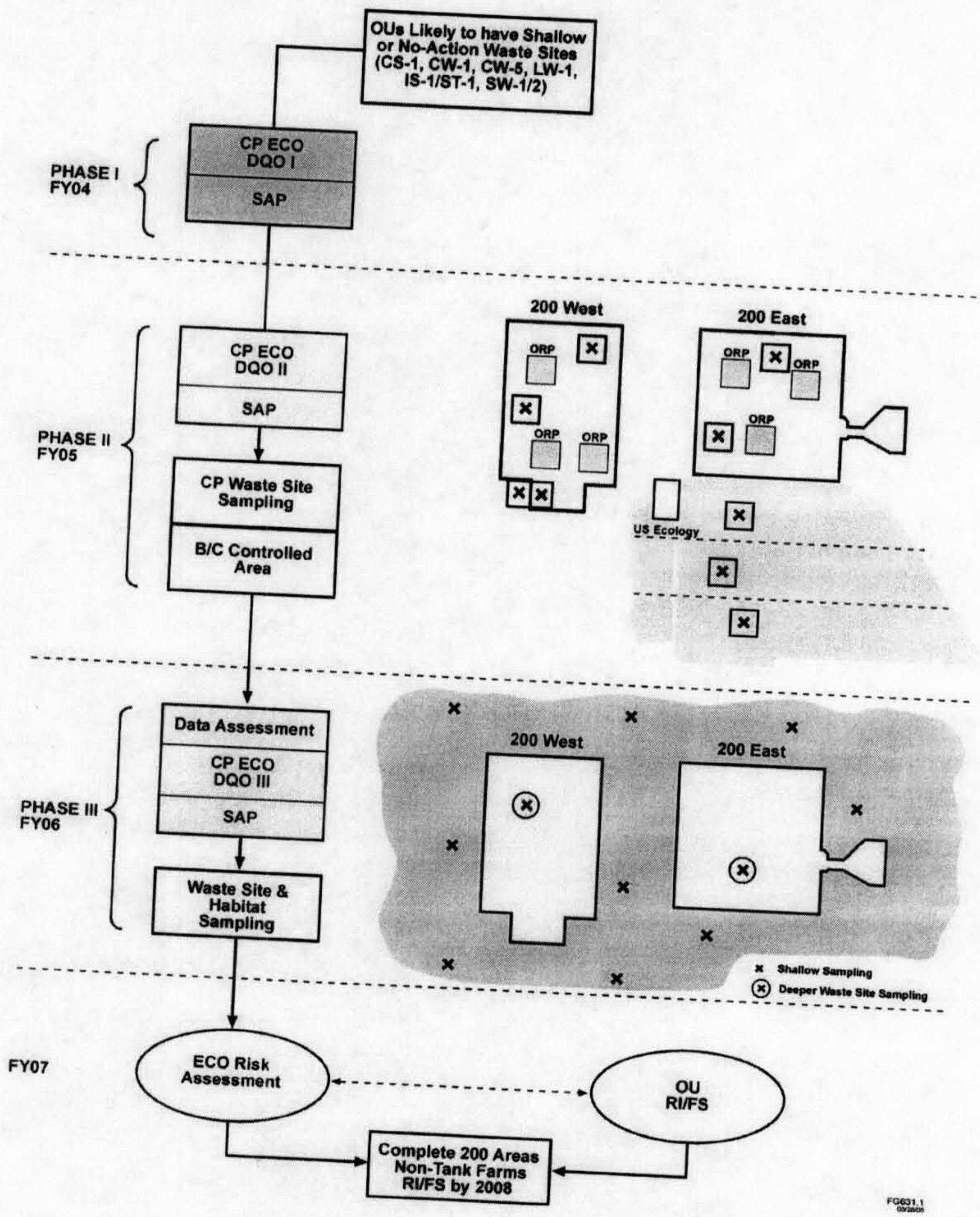
This document is the Phase II terrestrial ecological data quality objectives (EcoDQO) Phase II summary report for the Hanford Site Central Plateau. It is the second in a series of three summary reports (Phases I, II, and III) for assessing ecological risks on the Central Plateau. This document evaluates the need for acquisition of soil and biota data in support of waste site decision-making and information on the health or condition of the ecosystem across the range of Central Plateau habitats. The culmination of the phased data quality objectives (DQO)/sampling and analysis plans (SAP) and field characterization activities will be a final Central Plateau ecological risk assessment (ERA), planned for fiscal year 2007, as shown in Figure 1-1

> **Primary Objectives for the Central Plateau Ecological Data Quality Objectives**
>
> 1. Provide information to be used for waste site decision making.
> 2. Provide information to evaluate the health or condition of the ecosystem across habitats.

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1989) established a framework to ensure that environmental impacts associated with past and present activities at the Hanford Site are investigated and that appropriate response actions are taken to protect human health and the environment. Within this framework, the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study process is implemented to gather the information needed to arrive at records of decision that authorize remedial actions. The ERA supported by this DQO is one of several being performed on the Hanford Site to ensure that ecological risks have been properly evaluated in support of remedial action decision making. A Hanford Site risk assessment integration document has been issued to detail the relationships between the various risk assessments being performed (DOE/RL-2005-37, *Status of Hanford Site Risk Assessment Integration, FY 2005*). This document only addresses potential terrestrial ecological impacts on the Central Plateau. It does not address Central Plateau human health or groundwater impacts, nor does it consider ecological impacts in other portions of the Hanford Site.

The Central Plateau EcoDQO is being implemented using a phased and tiered approach to characterize ecological risks. Phases are based on spatial domains where investigation areas will be located; tiers are types of data collected within those investigation areas. Because of budgetary and schedule limitations that constrained the fiscal year 2004 activities, the spatial components of Phases I and II of the EcoDQO were characterized concurrently in fiscal year 2005. Phase I activities are focused on the CERCLA waste sites in the 200 East and 200 West Areas. Phase II will evaluate the need for ecological sampling in the US Ecology site, tank farms, the BC Controlled Area, and West Lake. Phase III is planned to evaluate the need for ecological sampling in habitat (non-operational) areas outside of the 200 East and 200 West Areas. This phased approach supports Tri-Party Agreement milestone M-015-00 for completion of the remedial investigation/feasibility study process for all operable units (OU) by December 31, 2008.

Figure 1-1. Phased Central Plateau Ecological Risk Assessment.



This document is based on Steps 3 and 4 of EPA/540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)* (ERAGS) (Figure 1-2), which represents the DQO process for ERAs. Chapters 2.0 through 6.0 of this document represent ERAGS Step 3, and Chapters 7.0 through 10.0 represent ERAGS Step 4.

In addition to following the ERAGS (EPA/540/R-97/006), relevant aspects of the more general ERA guidelines document (EPA/630/R-95/002F, *Guidelines for Ecological Risk Assessment*) are included to support development of the assessment endpoints (AE) by considering management goals. EPA/630/R-95/002F also provides additional guidance on ecological measures that will be addressed in this document. In proceeding through ERAGS Step 3, there will be scientific-management decision points for agreement on four items:

- Contaminated media
- Contaminants of potential ecological concern (COPEC)
- Assessment endpoints
- Risk questions.

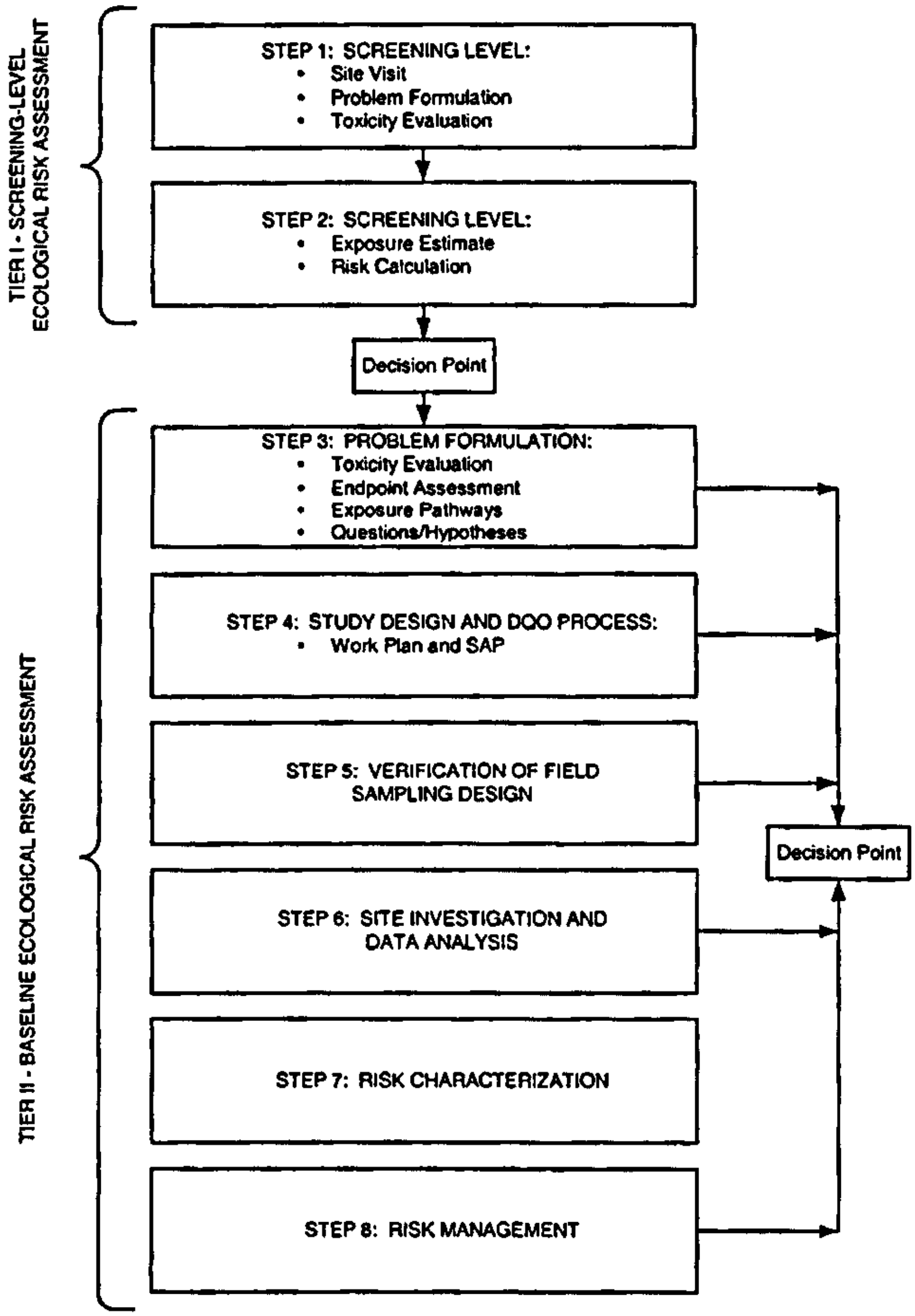
ERAGS Step 4 has scientific-management decision points on four additional aspects:

- Establishing measures
- Study design
- DQOs (including statistical considerations)
- The SAP, which will be provided as a separate document and therefore is not included in this document.

This summary report provides the basis for an ecological sampling design that will be carried forward into a SAP for field implementation. Ecological sampling data will assist in remedial action decision making where the consequences of remediation can be traded off against evidence for adverse ecological effects (Whicker et al. 2004, "Avoiding Destructive Remediation at DOE Sites"). Ultimately, ERAGS Step 8 (Figure 1-2) will be documented in a record of decision.

There are several unique considerations for performing an ERA at the scale of the Central Plateau. For example, ERAs typically are performed for individual waste sites. The risks posed by multiple chemicals and radionuclides associated with more than 700 waste sites grouped into OUs on the Central Plateau will need to be integrated in a comprehensive assessment to determine the potential for adverse effects on terrestrial biota. In contrast to typical ERAs, however, the means of performing this integration are available. While ecological information often is lacking in ERAs, there are decades of environmental monitoring data on the plants and animals of the Central Plateau. Compilations of important ecological information also are available for the Hanford Site (Landeen and Crow 1997, *A Nez Perce Nature Guide: I am of this Land* Wetes pe m'e wes; PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 15) and the Columbia Basin (O'Connor and Wieda 2001, *Northwest Arid Lands: an Introduction to the Columbia Basin Shrub-Steppe*). This wealth of ecological knowledge will be used to support remedial decision making in Phase II of the Central Plateau EcoDQO.

Figure 1-2. U.S. Environmental Protection Agency Two-Tier, Eight-Step Ecological Risk Assessment Process (adapted From EPA/540/R-97/006).



1.1 PROJECT SCOPE

The Tri-Party Agreement (Ecology et al. 1989) includes a site characterization and remediation strategy for the 200 Areas Central Plateau that addresses inactive waste sites, fuel reprocessing facilities, auxiliary buildings, planned and unplanned waste sites, and groundwater. The strategy is based on implementation of the CERCLA remedial investigation/feasibility study process, leading to records of decision that authorize remedial actions. The ERA supported by this DQO is one of several being performed on the Hanford Site to ensure that both human health and ecological risks have been properly evaluated in support of remedial action decision making. This document only addresses potential terrestrial ecological impacts on the Central Plateau. It does not address Central Plateau human health or groundwater impacts, nor does it consider ecological impacts in other portions of the Hanford Site. The relationship of the ERA supported by this DQO with other ERAs is presented in (DOE/RL-2005-37).

The scope of Phase I sampling initially focused on the evaluation of Central Plateau non-tank farm waste sites, to determine ecological impacts from contamination in support of remedial action decision making. Through the DQO process, issues and concerns were identified by the Tri-Party Agreement decision makers, National Resource Trustee Council members, Hanford Advisory Board, and Tribal participants that resulted in a significant expansion of the project scope (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*) to include consideration of Office of River Protection tank farm property, the US Ecology site, and habitat surrounding the Central Plateau waste sites.

Because of budgetary and schedule limitations that constrained the fiscal year 2004 activities, it was necessary to phase the ERA activities. As Figure 1-1 shows, Phase I activities are focused on the 200 East and 200 West Areas in the industrialized Core Zone; Phase II expands consideration of sampling to US Ecology and Office of River Protection sites in the Core Zone and the BC Controlled Area; and Phase III includes consideration of habitat sampling outside of the 200 East and 200 West Areas.

1.2 PROJECT OBJECTIVES

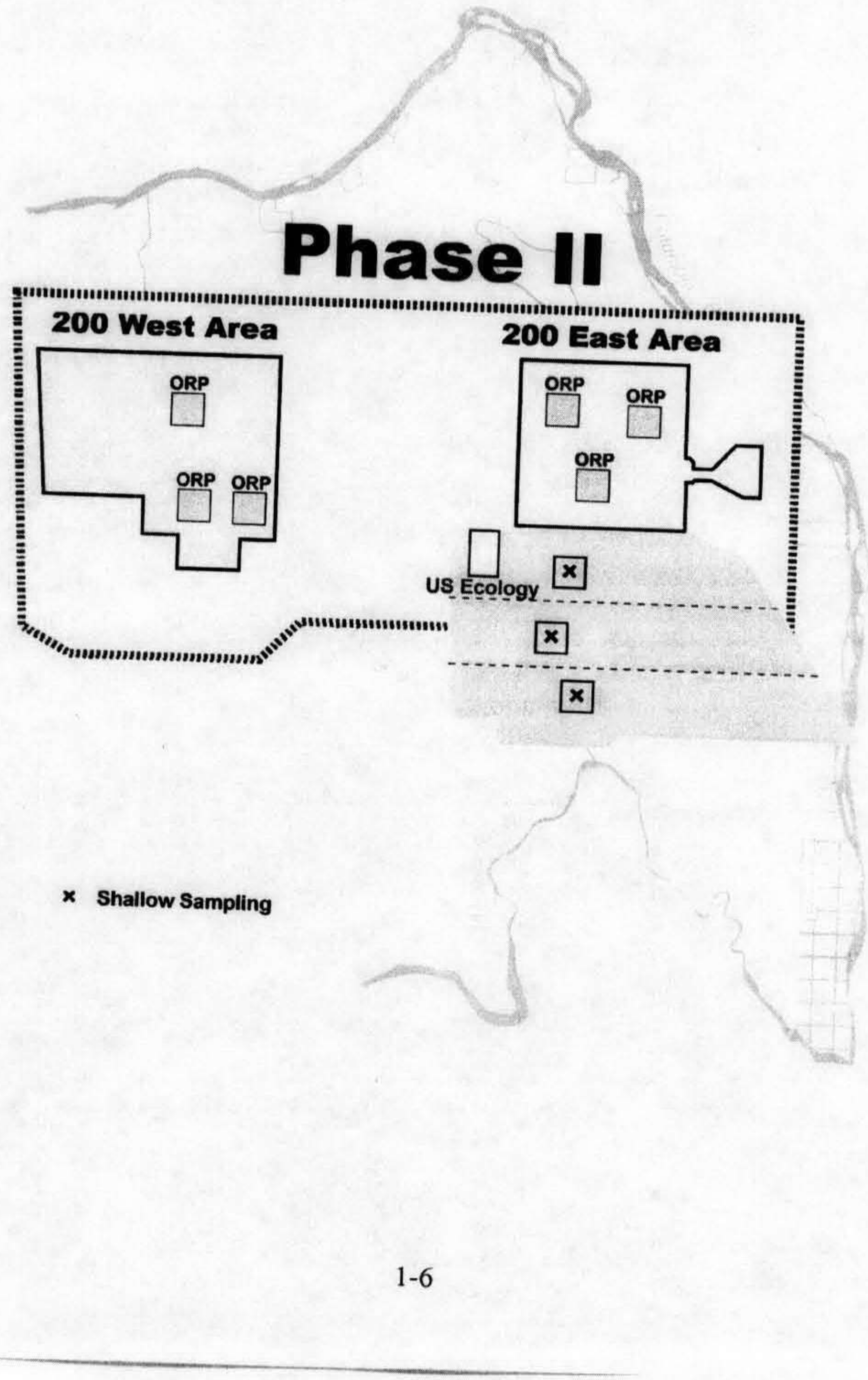
The two primary objectives of this Central Plateau terrestrial EcoDQO process are to provide information to be used for waste site decision making and to provide information to evaluate the health or condition of the ecosystem across habitats. An additional benefit that will result is that environmental information will be obtained that may assist the trustees in understanding the condition of the Central Plateau ecosystem.

1.3 TRUSTEE AND HANFORD ADVISORY BOARD INTERVIEW ISSUES

To help focus the scope of this DQO, the project team conducted interviews with the Tri-Party Agreement decision makers, National Resource Trustee Council representatives, Hanford Advisory Board members, and Tribal representatives. The interview issues and Tri-Party Agreement decision maker responses and positions were tabulated in an issues matrix table in Appendix A, Table A-1.

Figure 1-3. Spatial Areas Evaluated for Phase II of the Central Plateau EcoDQO.

(West Lake is included but is not shown in the figure.)



1.4 SCOPE OF PHASE II SAMPLING: SPATIAL DOMAINS CONSIDERED

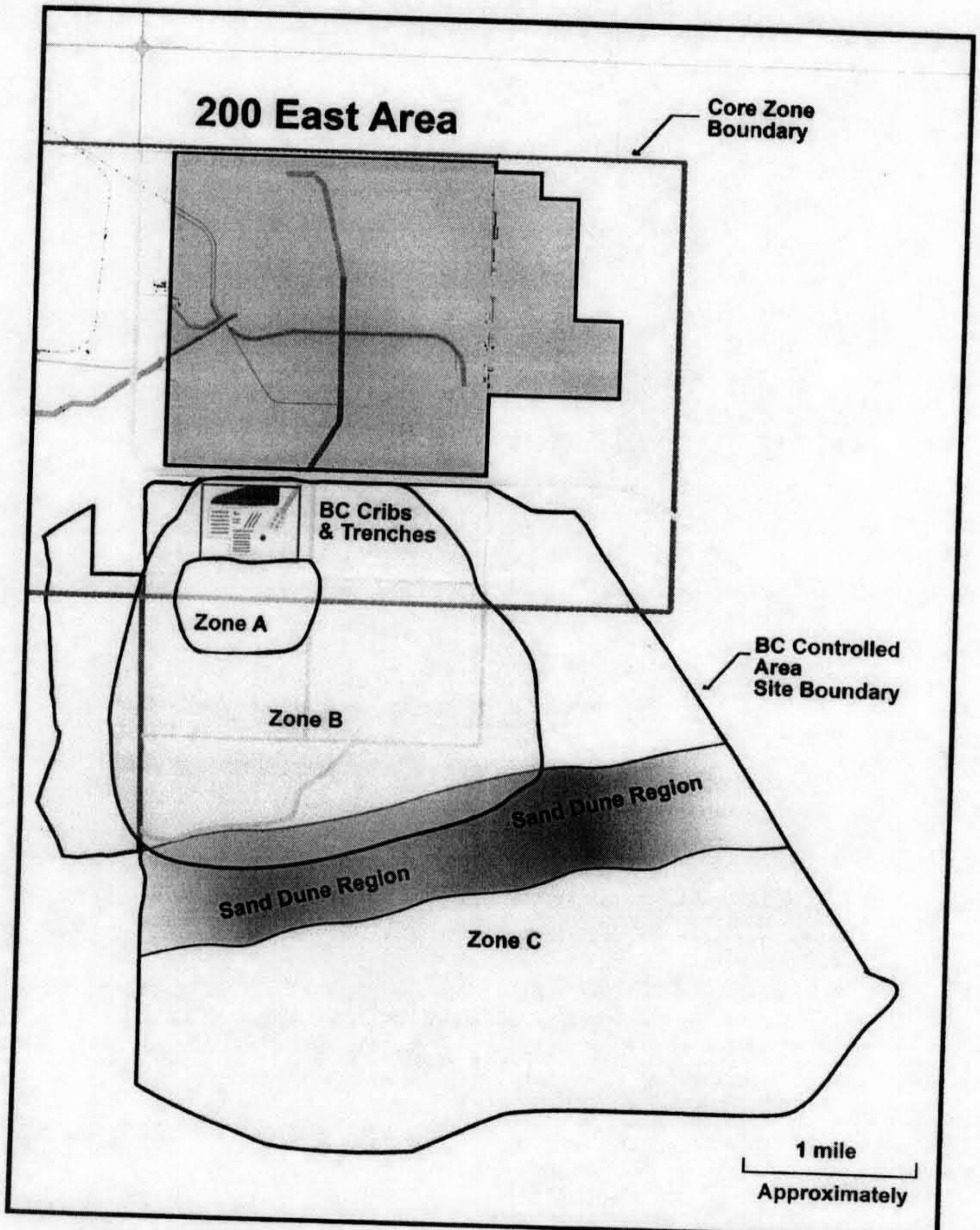
Background on the Central Plateau waste sites and the processes contributing to the waste sites within the industrialized Core Zone is addressed in the Phase I SAP (DOE/RL-2004-42, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I*). The terrestrial spatial domains under consideration in Phase II include the following: BC Controlled Area, US Ecology Site, and tank farm sites (Figure 1-3; West Lake also is considered but is not shown in the figure). The sections that follow evaluate the need for ecological sampling in the Phase II spatial domains considered.

1.4.1 BC Controlled Area

The BC Cribs and Trenches Area received wastes primarily from the Uranium Recovery Process and secondarily from 300 Area wastes (WMP-18647, *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*). For the BC Controlled Area, the aerial extent of which is 3,471 ha (13.4 mi^2; WMP-18647), the BC Cribs and Trenches Area were the source of contamination. Anecdotal information indicates that the trenches periodically were left open (e.g., over weekends) and animals drank from these and dispersed contaminants as a result. There also is evidence of biointrusion into trenches. It is postulated that animal burrows created access to radionuclide-contaminated salts; other animals ingested the salts and deposited radionuclides through defecation and urination, thereby contaminating what is now the BC Controlled Area to the south of the BC Cribs and Trenches Area.

The BC Controlled Area excludes the BC Cribs and Trenches Area; the Cribs and Trenches are being characterized in a separate OU, called the 200-TW-1 and 200-TW-2 OU, under a CERCLA remedial investigation/feasibility study work plan (DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*). The BC Controlled Area can be spatially delineated into three zones of relative radiation contamination levels (Figure 1-4). These zones are due south of the BC Cribs and Trenches Area and include the following: Zone A, showing the highest contamination levels; Zone B showing intermediate contamination; and Zone C having contamination levels similar to Hanford Site background. These zones are based on aerial radiological surveys and on surface radiological surveys documented in WMP-18647 and BHI-01319, *Data Assessment Report for the Sampling and Analysis Activities Conducted to Support Reposting the 200 B/C Contaminated Area*, Decisional Draft. In addition, surface soil and cryptogamic layer samples were collected from the same locations, and the data were reported in BHI-01319. The data showed good correlation between the levels of radionuclides in the soil and the cryptogamic layer. Soil samples were collected at locations of higher deposition based on radiological surveys. Soil samples were collected in March 2005 in the BC Controlled Area (D&D-24693, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*) to support the 200-UR-1 OU remedial investigation for metals and polychlorinated biphenyls (PCB) (Section 3.1.2 and Appendix B).

Figure 1-4. Conceptual Site Model Zones within the BC Controlled Area.



1.4.2 US Ecology

The US Ecology site is a commercial low-level radioactive waste disposal site within the boundaries of the Hanford Site. It is a licensed state facility and is not operated or regulated by the U.S. Department of Energy. Thus, the US Ecology site is not a CERCLA waste site, although it is operated on Federal land that is being leased to the State of Washington. The site has been in operation since 1965 and consists of containerized solid wastes that are buried under a cover of deep fill. The site contains radionuclides and a limited set of nonradioactive constituents.

Because the US Ecology site is not a CERCLA waste site, ecological data collected from the US Ecology site will not be used to support Central Plateau decision making. Furthermore, the US Ecology site is scheduled to remain operational for another 50 years (until 2056). The site is scheduled for closure when the lease expires in September 2063, which seems to further limit the utility of sampling current conditions at the US Ecology site and the local environs. As such, sampling is not planned for the US Ecology site in Phase II. It is recognized, however, that the potential exists for contaminants from the US Ecology site to influence surrounding habitat in the Central Plateau. Consequently, existing air monitoring data for the US Ecology site (air monitoring data from the Washington State Department of Health, Pacific Northwest National Laboratory, and other sources) will be evaluated. Such information will help determine if habitat adjacent to the US Ecology site should be considered in the possible assessment of the Central Plateau habitat areas in Phase III. This evaluation will occur as part of the Phase III DQO activity.

1.4.3 Tank Farms

The tank farms are actively managed by the U.S. Department of Energy Office of River Protection using herbicides, pesticides, and physical barriers to prevent biological intrusion. Little ecological habitat within the tank farm areas would attract biotic colonization (Figure 1-5).

However, some biological intruders do get into the tank farms; typically, they are captured and disposed of. Tank farm sites are being evaluated using the *Resource Conservation and Recovery Act of 1976* corrective action process. The resulting remedies almost certainly will change the quality of ecological habitat within the tank farms. Tank farms also are subject to interim stabilization methods that include removing liquids from the tanks and sampling the waste. Until all interim tank remediation is finished, final remedial alternatives will not be evaluated. For these reasons, tank farm sites are not appropriate for ecological sampling at this time. Preliminary biotic assessments are under way, and the methodologies and data resulting from the Central Plateau EcoDQO activities will be available and may be used to help guide future assessments and evaluations of data needs.

Figure 1-5. Photograph Illustrating Lack of Habitat at Tank Farm Sites.

1.4.4 West Lake

West Lake is a water body that had been on the earliest U.S. Geological Survey maps dating from the late 1800s. Although West Lake existed before the start of Hanford Site operations, West Lake's former expanse was largely a result of Plutonium-Uranium Extraction Plant wastewater discharge that elevated the water table. West Lake exists at a lower elevation than the Central Plateau, and geologic features cause water-level fluctuations following changes in the water table (PNL-7662, *An Evaluation of the Chemical Radiological and Ecological Conditions of West Lake on the Hanford Site*). West Lake's salinity and alkalinity favor the establishment of halophilic (salt-loving) plants and animals. The trophic relationships and organisms of West Lake are atypical of the Central Plateau's terrestrial environment, and the saline conditions preclude the use of West Lake as a drinking water source for terrestrial wildlife.

Contaminated media included soil, water, and sediment. Surface water was identified as the only medium of concern by a screening-level ERA. Operational water discharges dropped dramatically as of 1990, and the water table in the unconfined aquifer is slowly stabilizing toward pre-Hanford conditions. Because wastewater discharge has been discontinued in the 200 Areas, the lake has been shrinking in size. The aerial extent of surface water has been observed to be as small as 3 m^2 and as large as hundreds of square meters in 2004 and 2005. Thus, West Lake is dynamic and responds to climatological/seasonal conditions such as spring snow melt. Because West Lake represents a unique and changing ecological feature at the Hanford Site, further data compilation is under way. For example, in addition to those studies cited in WMP 20570; PNL-2499, *Comparative Ecology of Nuclear Waste Ponds and Streams on* *the Hanford Site*; and ARH-CD-775, *Geohydrologic Study of the West Lake Basin*, were consulted for a better understanding of the unique features of West Lake.

All existing West Lake information can be evaluated, and the data gaps can be defined and addressed in Phase III. EcoDQOs developed for West Lake in WMP-20570 will be revised upon receiving the most current information. Additional ecological characterization of West Lake, if necessary, will be coordinated with the potential remedial alternatives for West Lake and the associated groundwater OUs.

1.4.5 Spatial Domain Synopsis

Of the spatial domains considered for sampling in Phase II, only the BC Controlled Area is targeted for field data collection. Three investigation areas will represent the BC Controlled Area; one each in Zones A, B, and C (Figure 1-4). Radiological field data and soil analytical data suggest that the zones are relatively homogeneous with regard to contamination levels (Chapter 3.0). Consequently, one investigation area is appropriate to characterize ecological effects in each zone. A synopsis of the data collection activities and geographic areas addressed in Phase II and in Phase I (DOE/RL-2004-42) is presented in Table 1-1.

Table 1-1. Sampling Activities in the Proposed Investigation Phases, Structured by Study Area and Tier of Data Collection.

Phase	Study Area	Data Collection	
		Tier 1	Tier 2
I and II	Central Plateau waste sites	X	-
	BC Controlled Area	X	-
	Reference sites (bunchgrass and shrub)	X	-
III	Nonoperational (habitat) areas in the Central Plateau	TBD[a]	TBD
	BC Controlled Area	-	If needed[b]
	Reference sites (bunchgrass and shrub)	-	If needed
	West Lake	TBD	TBD
	Additional reference site(s)	TBD	TBD
	Central Plateau waste sites	-	If needed
	200 West Area diffuse carbon tetrachloride plume	TBD	TBD

[a] "TBD" or to be determined based on ecological data quality objectives developed for Phase III.
[b] "If needed" determination is based on data quality assessment results from the preceding phase.

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2.0 REFINE CONTAMINANT FATE AND TRANSPORT INFORMATION

Information on how chemicals and radionuclides are transported or transformed physically, chemically, and biologically is used to identify exposure pathways that might lead to significant ecological effects (EPA/540/R-97/006).

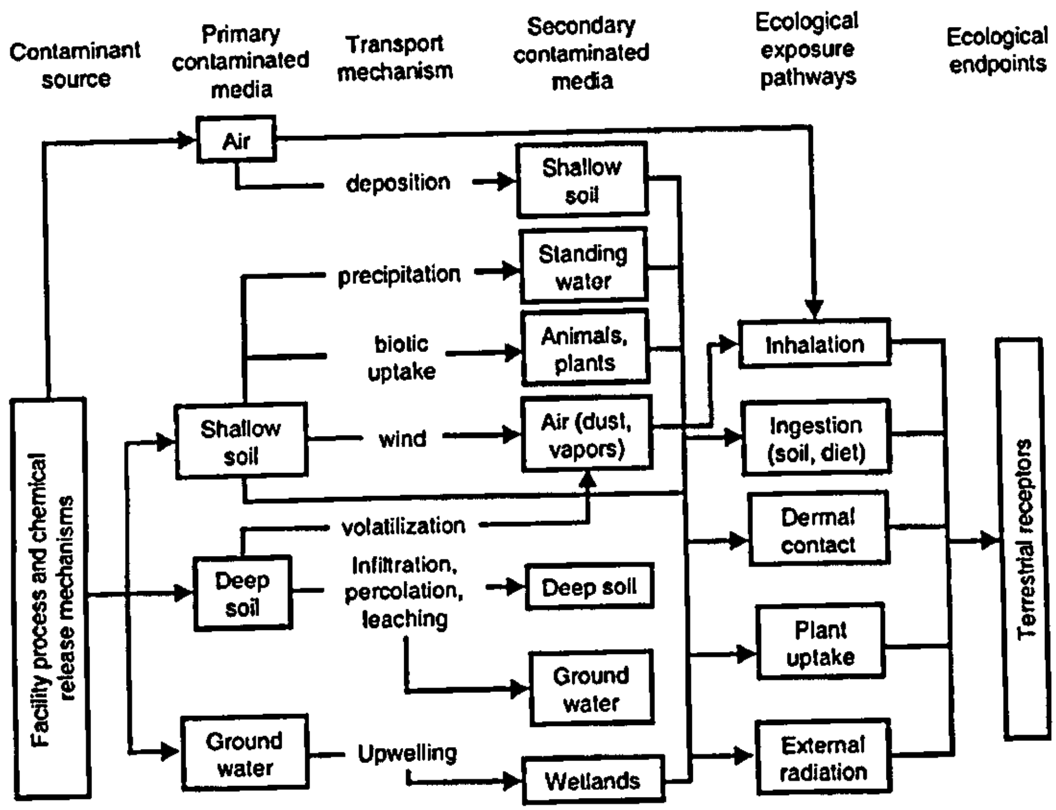
2.1 CONTAMINATED MEDIA AND EXPOSURE PATHWAY

To provide a comprehensive analysis of contaminant exposure, four primary impacted media were considered for the EcoDQO: air, groundwater, deep soil, and shallow soil (Figure 2-1).

Considering air, direct releases have occurred from facility operations. These airborne releases typically represented acute inhalation exposures. Airborne release also could represent longer term exposure after contaminants are deposited on surface soil. Inhalation of surface air is not typically a risk driver in ecological assessments (DOE-STD-1153-2002, *A Graded Approach For Evaluating Radiation Doses To Aquatic And Terrestrial Biota*; EPA 2003b, *Guidance for Developing Ecological Soil Screening Levels*, Attachment 1-3, *Evaluation of Dermal Contact and Inhalation Exposure Pathways for the Purposes of Setting Eco-SSLs*, OSWER 9285.7-55), but subsurface air may be an important exposure medium for solvents or other volatile organic chemicals emanating from the subsurface. For example, volatile organic chemicals, such as carbon tetrachloride, can partition from the surface or subsurface matrix into water and gas phases and emanate into animal burrows. Subsurface air as an exposure medium will be evaluated in Phase III based on available soil-gas data and other relevant monitoring data for volatile organic chemicals on the Central Plateau.

Considering groundwater, terrestrial plants and animals are unlikely to be exposed to this contaminated medium over most of the Central Plateau, because the shallowest depth to groundwater is approximately 61 m (200 ft) below ground surface (PNNL-14187-SUM, *Summary of Hanford Site Groundwater Monitoring for Fiscal Year 2002*). Groundwater does not come to the surface at any site in the Central Plateau except West Lake. Consequently, the pathway from groundwater to terrestrial receptors is largely incomplete (Figure 2-1). Terrestrial receptors can, however, be exposed to this medium where groundwater is discharged to the surface. West Lake is included in the scope of this EcoDQO and differs from other areas, because it is a wetland that partly resulted from groundwater discharges. An EcoDQO for West Lake was developed separately (WMP 20570; Appendix E) to simplify the focus of the main document on the terrestrial environment typical of the Central Plateau. West Lake will be further evaluated in Phase III.

Figure 2-1. Conceptual Model of Contaminated Media and Biotic Exposure Pathways Associated with Hanford Facility Processes.



The above considerations suggest that the EcoDQO focus should be on contaminated soil. Following precipitation events, shallow soil can contribute to a drinking water dose for wildlife in the form of suspended soil particles in standing water (Figure 2-1). Shallow soil also is a potential source for contaminated air via eolian processes (Figure 2-1). While there is a potentially complete exposure pathway via inhalation of particulates, a U.S. Environmental Protection Agency exposure pathway analysis (Table 2-1) indicates that inhalation of particulates is a minor exposure route for terrestrial receptors. For example, inhalation of particulates is <0.001 percent of total exposure for the meadow vole (EPA 2003b), the terrestrial mammalian herbivore identified in the *Washington Administrative Code* (WAC) terrestrial ecological evaluation (TEE) (see WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures," for TEE procedures). In fact, incidental soil ingestion (e.g., through preening, fur cleaning) and dietary ingestion represent more than 99.8 percent of total vole exposure for the chemicals in Table 2-1. Ingestion through the diet accounts for eating contaminated plants. The Hanford Site conceptual exposure model (Figure 2-1) explicitly accounts for bioaccumulation and trophic transfer (i.e., ingestion of contaminated plants and animals) of site contaminants.

Table 2-1. Relative Dose Contributions for the Meadow Vole Associated with Shallow Soil Exposure (after EPA 2003b).

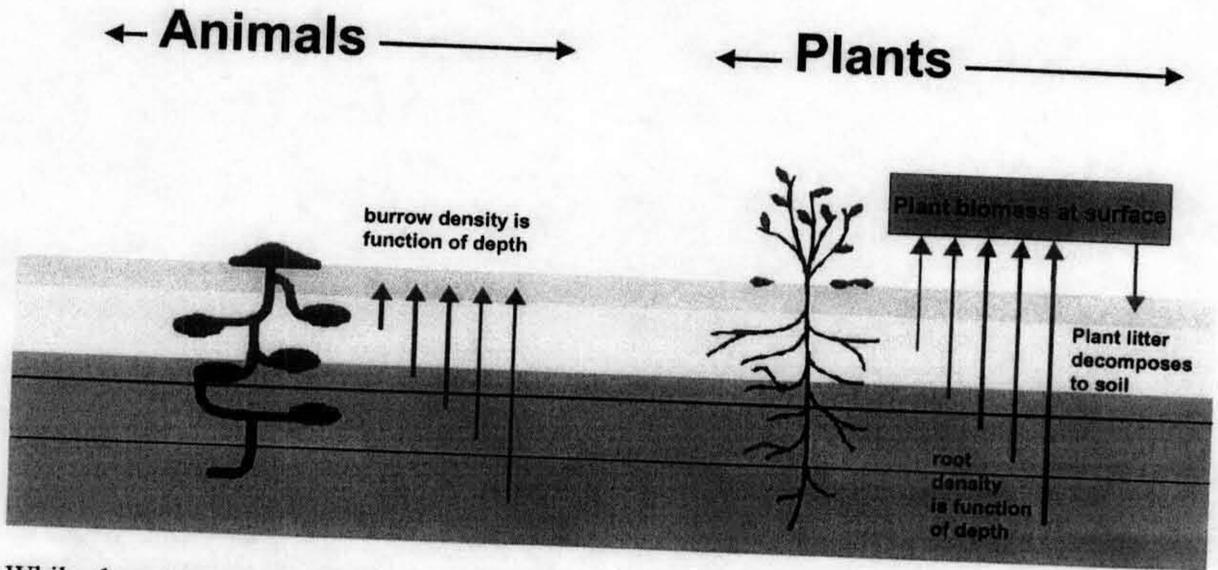
Analyte	Exposure (%)			
	Soil Ingestion	Plant Ingestion	Dermal	Inhalation
Lead	38	63	0.02	<0.001
Fluoranthene	37	63	0.2	<0.001
DDT	79	21	0.1	<0.001

EPA 2003b, *Guidance for Developing Ecological Soil Screening Levels*, Attachment 1-3, *Evaluation of Dermal Contact and Inhalation Exposure Pathways for the Purposes of Setting Eco-SSLs*.
DDT = dichloro-diphenyl-trichloroethane.

A complete pathway exists for dermal contact from shallow soil, but the fur and feathers of wildlife serve as an effective barrier to soil exposure (EPA 2003b). Consequently, dermal contact is a less important component of total exposure relative to direct ingestion pathways (Table 2-1). Foliar and dermal contact or root uptake is important to ecological receptors such as plants and soil invertebrates, considering their close association with soil. For wildlife, however, the low contribution of the inhalation and dermal exposure pathway to total exposure justifies focusing on the ingestion pathways in developing and prioritizing AEs and risk questions for the Central Plateau ERA. An understanding of dietary exposure involves an assessment of biological trophic level linkages for the Central Plateau.

Because a component of the EcoDQO scope is to support remediation decisions, it is necessary to evaluate the soil depth where cleanup is required. The WAC defines the soil cleanup depth (the standard point of compliance) as extending from the ground surface to 41.6 m (15 ft) below ground surface (WAC 173-340-7490[4][b], "Terrestrial Ecological Evaluation Procedures," "Point of Compliance," "Standard Point of Compliance"). This cutoff depth was chosen as a reasonable estimate of the soil depth that could be excavated and distributed at the soil surface as a result of site development activities that result in exposure by terrestrial receptors. The WAC also allows for a conditional point of compliance (1.8 m [6 ft]; WAC 173-340-7490[4][a], "Terrestrial Ecological Evaluation Procedures," "Point of Compliance," "Conditional Point of Compliance") to be set at the biologically active zone. The depths to which insects, animals (burrows), and plants (roots) are likely to occur define the biologically active zone. The working hypothesis is that biological activity is limited largely to the top 1.8 m (6 ft), and to test this hypothesis it is useful to construct a model of biotic activity (Figure 2-2).

Figure 2-2. Conceptual Model of Biotic Activity in the Soil Environment.



While aboveground activity is essential for many animals and terrestrial plants, in arid environments like the Hanford Site, exploitation of the subsurface also is required for survival (PNL-4140, *Habitat Requirements and Burrowing Depths of Rodents in Relation to Shallow Waste Burial Sites*). Burrowing is a successful life-history strategy for animals in dry lands (Meadows and Meadows 1991, *The Environmental Impact of Burrowing Animals and Animal Burrows*), and many desert animals burrow for shelter from environmental conditions, reproduction, foodstuff procurement, and water conservation (Rundel and Gibson 1996, *Ecological Communities and Processes in a Mojave Desert Ecosystem: Rock Valley, Nevada*). Burrowing results in significant soil turnover, and much of this reworking is caused by the fossorial activity of pocket gophers, ground squirrels, mice, and kangaroo rats. In addition, predators of burrowing mammals, particularly foxes, coyotes, and badgers, contribute to turnover of the top 1.8 m (6 ft) of soil (Chapman and Feldhamer 1982, *Wild Mammals of North America: Biology, Management, Economics*).

Soil macroinvertebrates also burrow extensively in deserts. For example, some species of spiders are known to burrow (e.g., trap-door spiders) albeit shallowly (usually less than 15 cm [6 in.]), which also is the case for many species of arid system beetles such as the ubiquitous *Eleodes spp.* and other darkling beetles. Considering the Hanford Site, harvester ants are likely the deepest burrowing animals that occur on the Central Plateau. Five colonies of *Pogonomyrmex owyheei* were excavated on the Hanford Site at depths ranging from 1.7 to 2.7 m (5.6 to 8.8 ft), with an average depth of 2.3 m (7.5 ft) (PNL-2774, *Characterization of the Hanford 300 Area Burial Grounds: Task IV – Biological Transport*).

Plants, of course, rely on extensive belowground biomass to capture nutrients and water. The extent of the rooting systems for species in the 200 Areas was evaluated by the Pacific Northwest Laboratory (PNL-5247, *Rooting Depth and Distribution of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site*). This study concentrated on plant species suspected of having deep root systems and species that have been reported in previous studies to contain radionuclides in aboveground parts. Maximum depths for several of the deepest rooted plant species at the Hanford Site are presented in Table 2-2 (PNL-5247). These maximum rooting depths are consistent with the majority of plant species in a literature review of rooting depth by vegetation types (Canadell et al. 1996, "Maximum Rooting Depth of Vegetation Types at the Global Scale"). This review indicates that 194 of 253 species had maximum rooting depths of 2 m (6.6 ft) or less, but maximum depths extended to greater than 20 m (66 ft) for some species. Tree and shrub species were reported to have the deeper maximum rooting depths.

Information also is provided in Table 2-2 for the deeper burrowing mammal and ant species (PNL-2774; RHO-SA-211, *Intrusion of Radioactive Waste Burial Sites by the Great Basin Pocket Mouse* (Perognathus Parvus)). None of the maximum depths reported for plant or animal species were greater than 3 m (10 ft), well above the 4.6 m (15-ft) interval defined for applicability of shallow zone screening thresholds (WAC 173-340-7490[4][b]), which indicates that the pathway from deep soil to ecological receptors is incomplete (Figure 2-1). The Hanford Site-specific data indicate that the shallow zone soil (<4.6 m [15 ft] below ground surface) is the primary contaminated medium of concern for ecological receptors.

Shallow zone soils consequently are the focus of further exposure assessment for Central Plateau terrestrial receptors. In considering the subsurface extent of plant roots or animal burrows, it is important to realize that burrow and root density are not continuous from the soil surface to the maximum reported depths. The burrow fraction is heavily weighted to shallow soils and dramatically declines with depth from the ground surface; similarly the density of plant roots declines with depth (Figure 2-3). The data used to generate this figure are provided in WMP-20570, Appendix F.

Kennedy et al. 1985, "Biotic Transport of Radionuclide Wastes from A Low-Level Radioactive Waste Site", and Reynolds and Laundré 1988, "Vertical Distribution of Soil Removed by Four Species of Burrowing Rodents in Disturbed and Undisturbed Soils," present data for pocket mice, kangaroo rats, pocket gophers, and ground squirrels to illustrate how burrow density is a function of depth (Figure 2-3). The y-axis represents the burrow density above a given depth in the subsurface. For example, 90 percent of the burrow density is located above a depth of 140 cm (55 in.). Excepting the kangaroo rat, these arid-adapted mammals are all Hanford Site species (PNNL-SA-32196, *Hanford Site Ecological Monitoring & Compliance*, "Hanford Site Species Listings," last updated December 11, 2000, available on the Internet at http://www.pnl.gov/ecomon/Species/Mammal.html). The root mass of deeply rooting desert shrubs also is weighted toward greater density near the surface and, similar to mammalian burrow density, root mass declines with depth. Thus, while certain plants and animals have maximum rooting or burrowing depths many feet into the subsurface, it is clear that most of the biotic activity for these species is in the top few feet of the soil column.

Table 2-2. Maximum Plant-Rooting Burrowing Depth for Hanford Site Receptors.

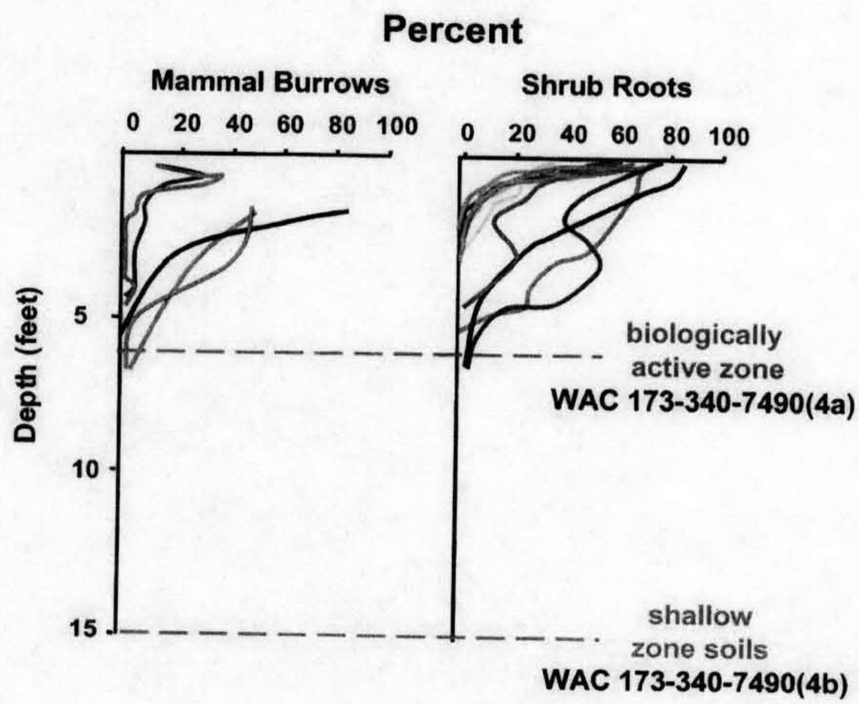
Species	Maximum Depth (cm)	Maximum Depth (ft)	Reference
Plants			
Antelope bitterbrush	300	9.8	PNL-5247
Big Sagebrush	200	6.6	PNL-5247
Spiny hopsage	195	6.4	PNL-5247
Russian thistle	172	5.6	PNL-5247
Mammals			
Great Basin pocket mouse	200	6.6	RHO-SA-211
Soil Biota			
Harvester ants	270	8.8	PNL-2774

PNL-2774, *Characterization of the Hanford 300 Area Burial Grounds: Task IV – Biological Transport.*

PNL-5247, *Rooting Depth and Distribution of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site.*

RHO-SA-211, *Intrusion of Radioactive Waste Burial Sites by the Great Basin Pocket Mouse (*Perognathus Parvus*).*

Figure 2-3. Burrow and Root Density as a Fraction of Depth Below the Ground Surface.



Given the Phase II focus on the BC Controlled Area, it is important to consider the transport mechanisms for contamination originating from the BC Cribs and Trenches Area. WMP-18647 cites studies indicating that animals ingested contaminated salts from the cribs and trenches and spread this contamination over the surface of soils in the proximity of the cribs and trenches. Consequently, it is of interest to evaluate how surface-applied contaminants move through what is now the BC Controlled Area.

In the mid-1950s, an experimental situation was set up that is analogous to the contaminant dispersal that occurred at the BC Controlled Area. This was the Hanford Site's Strontium Gardens research, wherein Cs-137 and Sr-90 were applied to the soil surface on plots near the 100-F Reactor (Cline and Rickard 1972, "Radioactive Strontium and Cesium in Cultivated and Abandoned Field Plots"). This experimental application represents approximately the same time that radiological contaminants were dispersed from the BC Cribs and Trenches Area into what is now the BC Controlled Area. Cline 1981 ("Aging Effects on the Availability of Strontium and Cesium to Plants") and Cline and Cadwell 1984 ("Movement of Radiostrontium in the Soil Profile in an Arid Climate") showed that 70 percent of the surface-applied Cs-137 was remaining in the top 2.5 cm (1 in.) after 8 years and that the peak in Sr-90 activity was at 15 cm (6 in.) below the ground surface after 25 years.

It is possible that biological transport or other transport mechanisms can lead to distributing contamination on the ground surface (i.e., the first few millimeters) to deeper depths. This may lead to distributing contaminants into soil at deeper than 15 cm (6 in.). However, this process would gradually blend high concentrations in the surface into lower concentrations at deeper depths, and samples collected from the top 15 cm (6 in.) should be representative of the greatest contaminant concentrations. In addition, Cline and Cadwell (1984) speculated that surface-applied radionuclides would remain homogeneously distributed in the top 0.3 m (1 ft) and would decrease over time through radiological decay. Thus, surface samples (of the first 15 cm [6 in.]) will capture representative radionuclide levels in BC Controlled Area soils.

Collecting surface soil samples for the initial data collection activities has important practical advantages. Surface soils can be collected along with specific biological samples to test for COPEC uptake. Methods for collecting surface soil samples also are less intrusive than those needed for deeper soil characterization (e.g., truck-mounted drill rigs); therefore, such methods minimize the impacts of data collection on the shrub-steppe ecosystem. The conceptual model of the possible downward mobility of surficial contamination through animal burrowing and plant uptake also will be initially assessed, using field radiological data.

2.2 CONTAMINATED MEDIA AND EXPOSURE PATHWAY SYNOPSIS

The major points covered in Chapter 2.0 are as follows.

- Shallow zone soil (<4.6 m [15 ft]) is the contaminated medium with the greatest exposure potential for Central Plateau terrestrial receptors and is therefore the most relevant to deriving COPECs, AEs, and risk questions.
- Transport mechanisms from the BC Cribs and Trenches Area (e.g., animal transport) resulted in surficial contaminant deposition in the BC Controlled Area.
- The top 15 cm (6 in.) of shallow soil in the BC Controlled Area represent maximum contaminant concentrations and will therefore be the focus of data collection for this investigation.

Complete pathways of lesser importance, like dermal contact and inhalation of particulates, will be considered in a qualitative manner in the risk assessment.

3.0 REFINE CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

COPEC identification is part of ERAGS Step 3, "COPEC refinement," which has the objective of determining the contaminants that warrant additional investigation to evaluate ecological risks. A conceptual model is developed and AEs are defined based on COPECs and the ecological receptors potentially at risk. This information leads to the formulation of risk questions and measures of exposure, effect, and ecosystem/receptor characteristics needed to evaluate the risk questions. A study design is developed based on the COPECs, AEs, risk questions, and measures.

3.1 DATA EVALUATION

3.1.1 Radionuclide Contaminants of Potential Ecological Concern

Of the spatial domains considered for sampling in Phase II, only the BC Controlled Area is targeted for data collection. As discussed in WMP-18647, previous analyses have used radiological field data and soil analytical data to delineate the three zones representing the BC Controlled Area; Zones A, B, and C (Figure 1-4). Considering that contamination from the BC Cribs and Trenches Area was deposited on the soil surface of what is now the BC Controlled Area (Chapter 2.0), surficial soil data are relevant to characterizing radiological contamination in this area. Applicable existing data include the recently collected surface soil samples from BHI-01319. Locations sampled in BHI-01319 are overlaid on an aerial radiological survey map of the BC Controlled Area in Figure 3-1 (EGG-1183-1661, *An Aerial Radiological Survey of the U.S. Energy Research and Development Administration's Hanford Reservation [Survey Period: 1973-1974]*). Relative to Figure 1-4, Zone A may be represented by the sampling locations S1 through S7, and Zone B may be represented by locations S8 through S13.

Given the sole focus on the BC Controlled Area for sampling, the Phase II radiological COPECs are based on existing BC Controlled Area data; specifically, using maximum radionuclide results in surface soil as reported in BHI-01319. Use of the maximum soil concentrations is expected to be protective of adverse effects on both the populations and the more sensitive individuals in these populations (DOE-STD-1153-2002; DOE/EH-0676, *RESRAD-BIOTA: A Tool for Implementing A Graded Approach to Biota Dose Evaluation*). Because adsorbed dose rates of ionizing radiation are additive, and because multiple radionuclides are being evaluated (Jones et al. 2003, "Principles and Issues in Radiological Ecological Risk Assessment"), the contribution of radionuclides known to be associated with Hanford Site processes was calculated. This calculation is based on the sum-of-fractions (SOF) method, and the contributions of various radionuclides were reviewed to determine their contribution to dose.

Figure 3-1. Surface Soil Radionuclide Sampling Locations in the BC Controlled Area (WMP-18647).

$$SOF = \sum_{j=1}^{n} Exposure_j / BCG_j$$

where

SOF = sum of fractions

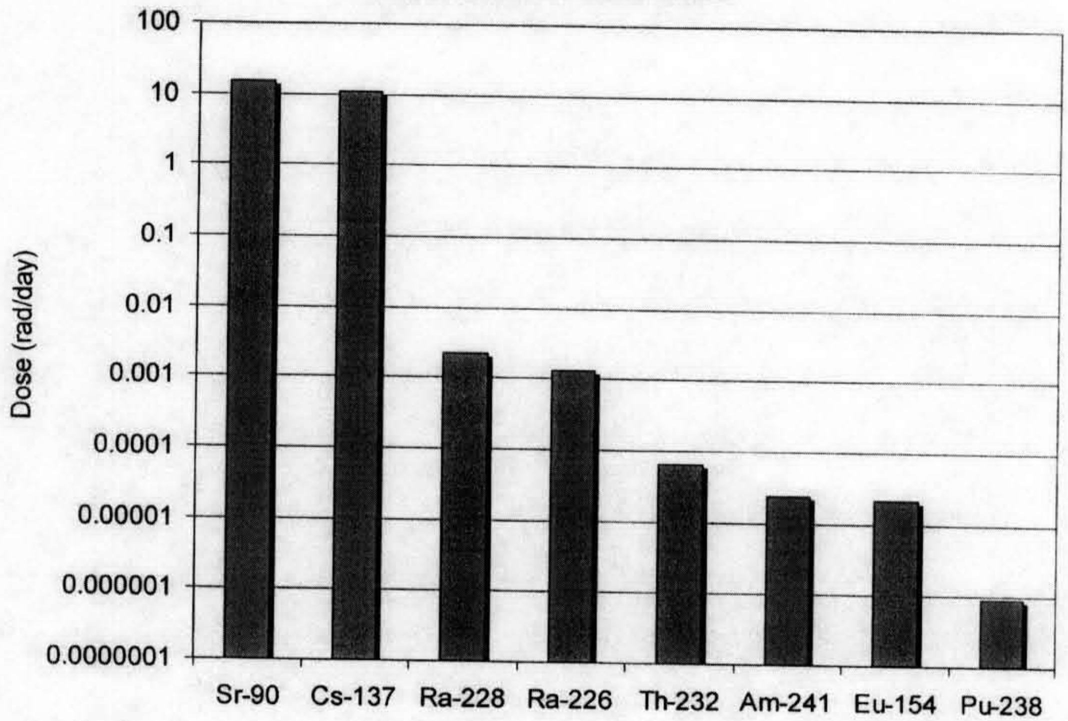
$Exposure_j$ = exposure concentration for radionuclides

BCG_j = biota concentration guideline for $radionuclide_j$.

The process for evaluating radionuclides includes the SOF calculation and comparison to background (DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for*

Radionuclides). The SOF calculation is based on the maximum radionuclide concentrations divided by the biota concentration guideline (BCG) for all radionuclides in BC Controlled Area surficial soils (BHI-01319). The SOF of these data is 262 (or equal to dose of 26 rad/day), of which Sr-90 represents 58 percent and Cs-137 is 42 percent of the SOF; other radionuclides contributed less than 0.001 percent of the SOF (Figure 3-2).

Figure 3-2. BC Controlled Area Dose Based on Maximum Surface Soil Radionuclide Concentrations.



Dose based on Cs-137 and Sr-90 maxima in each zone are plotted in Figure 3-3. The doses remaining after 200 years of radionuclide decay are presented alongside current-day dose for the radioactivity remaining after institutional control of the BC Controlled Area is relinquished Zone C may be represented by soil samples collected near the southern boundary of the BC Controlled Area (WHC-EP-0771, *Comparison of Radionuclide Levels in Soil, Sagebrush, Plant Litter, Cryptogams and Small Mammals*), and results from the most representative locations were likewise evaluated (WHC-EP-0771, sampling locations B0-B5). Similar to Zones A and B, cesium and strontium represented 99.8 percent of the Zone C radiation dose. These soil analytical results are consistent with the aerial radiological surveys showing that Zone A has the highest radioactivity levels, Zone B is intermediate, and Zone C has background radioactivity levels. Consequently, Cs-137 and Sr-90 are the Phase II radionuclide COPECs (Table 3-1).

Figure 3-3. BC Controlled Area Dose by Zone; Current Maximum, and Decayed Values for Cesium-137 and Strontium-90 Relative to Background.

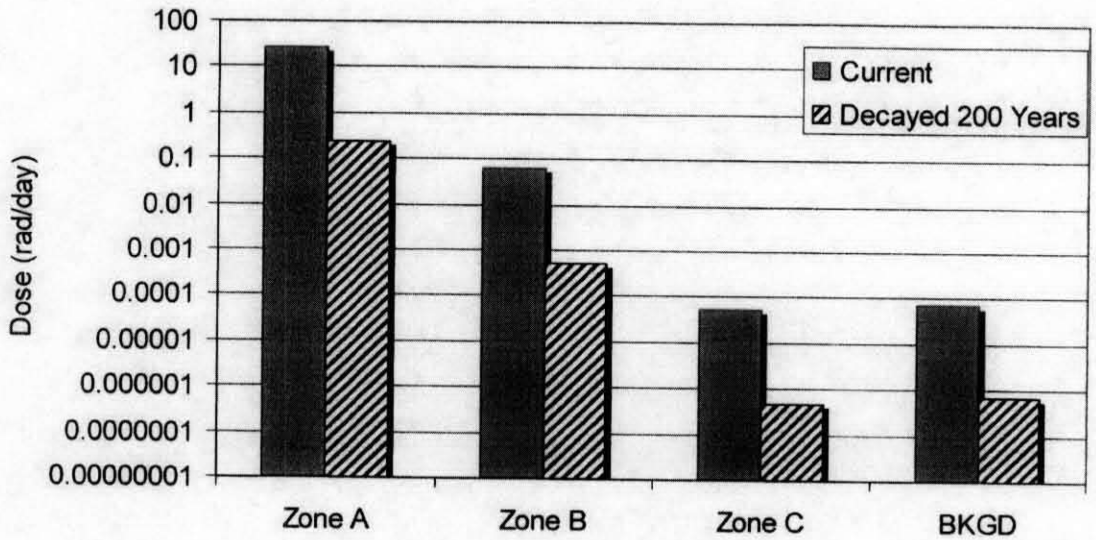


Table 3-1. Draft Refined List of Central Plateau Contaminants of Potential Ecological Concern.

Analyte	No. of Samples	No. of Detects	Maximum Detect	FD>BV[1]	FD>SSV[2]
Cesium-137	13	13	2290	0.69	0.62
Strontium-90	13	13	3420	1.00	0.061

Data obtained from BHI-01319, *Data Assessment Report for the Sampling and Analysis Activities Conducted to Support Reposting the 200 B/C Contaminated Area*; pCi/g = picocuries per gram.

[1] Frequency of detects (FD) greater than the background value (BV), DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

[2] Frequency of detects (FD) greater than the soil-screening value (SSV) out of all samples analyzed. Soil screening values for radionuclides are based on DOE/EH-0676, *RESRAD-BIOTA: A Tool for Implementing A Graded Approach to Biota Dose Evaluation*, biota concentration guidelines for plants and for terrestrial wildlife.

3.1.2 Nonradionuclide Contaminants of Potential Ecological Concern

The nonradionuclide COPECs were based on a characterization activity that analyzed BC Controlled Area soils for metals, total uranium, anions, and total PCBs under the 200-UR-1 OU remedial investigation (D&D-24693). Samples were collected from the most highly contaminated locations and from moderately contaminated locations in the BC Controlled Area; specifically, Zone A hotspots as well as randomly selected locations in Zones A and B. This activity was based on the assumption that nonradionuclides coincide with the radionuclides. Nonradionuclide analyses on these samples included inorganic chemicals, anions, and Aroclors[1], which are the same nonradionuclide suites (excepting pesticides) identified in the Phase I EcoDQO (WMP-20570) and Phase I SAP (DOE/RL-2004-42).

Sixteen samples from Zones A and B were analyzed. WAC soil screening values (SSV) (WAC 173-340-900, "Tables," Table 749-3) and Hanford Site background soil concentrations (90^{th} percentile values from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*) lead to a comparison value for the maximum detected concentrations of each analyte. Detected values less than the comparison value are eliminated as COPECs. Analytes that are all nondetects are not compared to background or carried through evaluation. WAC 173-340-900 employs toxicity reference values (TRV) based on lowest observed adverse-effect levels (WAC 173-340-900, Table 749-5) and plant/soil biota SSVs based on lowest observed effect concentrations (WAC 173-340-900, Table 749-3).

Aroclors were eliminated as COPECs, because they were not detected (detection limits for Aroclors were less than the WAC total PCB SSV). Inorganic analytes also were dropped from the initial COPEC list if they were within the range of background concentrations (DOE/RL-92-24,) or were below applicable SSVs. Ecology 94-115, *Natural Background Soil Metals Concentrations in Washington State,* also was used for background concentrations (using 90^{th} percentile values) where no site-specific background concentrations were available (e.g., cadmium). For the metals, none of the detected analytes exceeded background or WAC SSVs. These results are provided in Appendix B. Consequently, no nonradionuclide COPECs are identified for Phase II.

3.2 CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN REFINEMENT SYNOPSIS

The major points covered in Chapter 3.0 are as follows.

- Nonradionuclide inorganic chemicals and organic chemicals did not exceed background values or Washington State soil screening values.
- Organic chemicals did not exceed Washington State soil screening values.
- Given the predominance of Cs-137 and Sr-90 in BC Controlled Area soils, these radionuclides are the Phase II COPECs.

The resulting Phase II analytical suites are gamma energy analysis and radiostrontium.

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[1] Aroclor is an expired trademark.

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4.0 ASSESSMENT ENDPOINTS

Assessment endpoints are a combination of an entity at risk and an attribute of the entity at risk. For example, some metal COPECs may affect native plants by manifesting toxicity as seedling mortality. Seedling survival is therefore an attribute of plants that are at risk. Stating AEs in this manner facilitates transparent and objective management goals. The attributes of Central Plateau AEs are selected in Chapter 5.0.

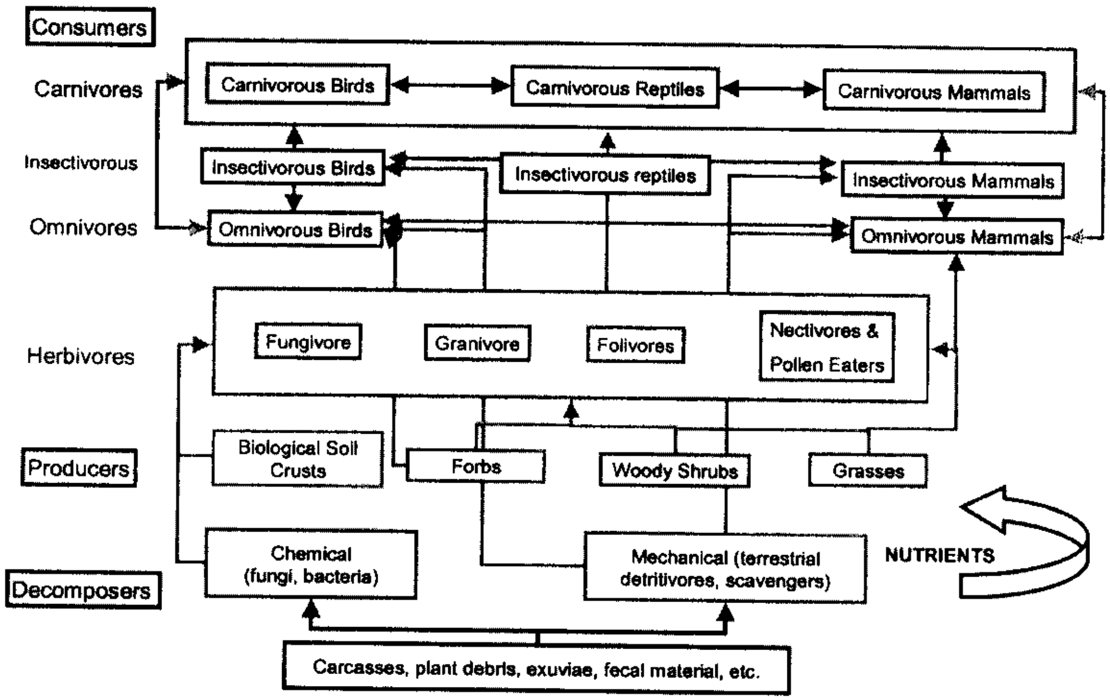
4.1 MANAGEMENT GOALS

Several management goals specific to the potential impact of contaminants on the Central Plateau ecological receptors have been proposed. Management goals include considering impacts to special status species, considering if contaminants are adversely impacting plants and invertebrates, maintaining the health of the Central Plateau ecosystem by maintaining soil fertility, and minimizing contaminant loading (or bioaccumulation) into Central Plateau biota. Special status species include migratory bird species, and some of these migratory bird species also are state-listed species. The primary ERA goal for CERCLA is to reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota (EPA 1999, *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (Memorandum), OSWER Directive 9285.7-28P). Thus, assessment of possible impacts of contaminants on ecological populations is needed. These management goals are integrated with the results of the physical model (contaminated media) and COPEC refinement to develop AEs. The entities selected as AEs are based on an understanding of ecological interactions among Central Plateau plants, soil biota, and wildlife as described in the next section. The evaluation of AEs may involve direct measures on the endpoint in question or, if this is logistically impractical, may involve measures on a surrogate for the AE.

4.2 BIOLOGICAL TROPHIC-LEVEL LINKAGES

Ingestion (dietary and incidental soil ingestion) and direct contact are the important exposure pathways for the Central Plateau COPECs, and these pathways are efficiently represented by a functional food web. Functional groups in conceptual models are represented as general classes of organisms sharing common characteristics. For example, ecological systems are composed of many feeding relationships. Some organisms prey on plants (herbivores), plants and animals (omnivores), or just animals (carnivores). More specific feeding classes exist with a particular trophic category. For examples, herbivores are represented by granivores (seed-eating animals), folivores (stem- and leaf-eating animals), fungivores (fungi-eating animals), and nectivores (nectar-drinking animals). In this case, the functional components of the ecosystem are defined on the basis of their role in the food web. EPA/540/R-97/006 recommends using this approach to describe ecological relationships and to develop a feeding-guild-based conceptual model of the Central Plateau terrestrial ecological system (Figure 4-1).

Figure 4-1. Terrestrial Ecological Food Web Represented by Simplified Feeding Guilds.

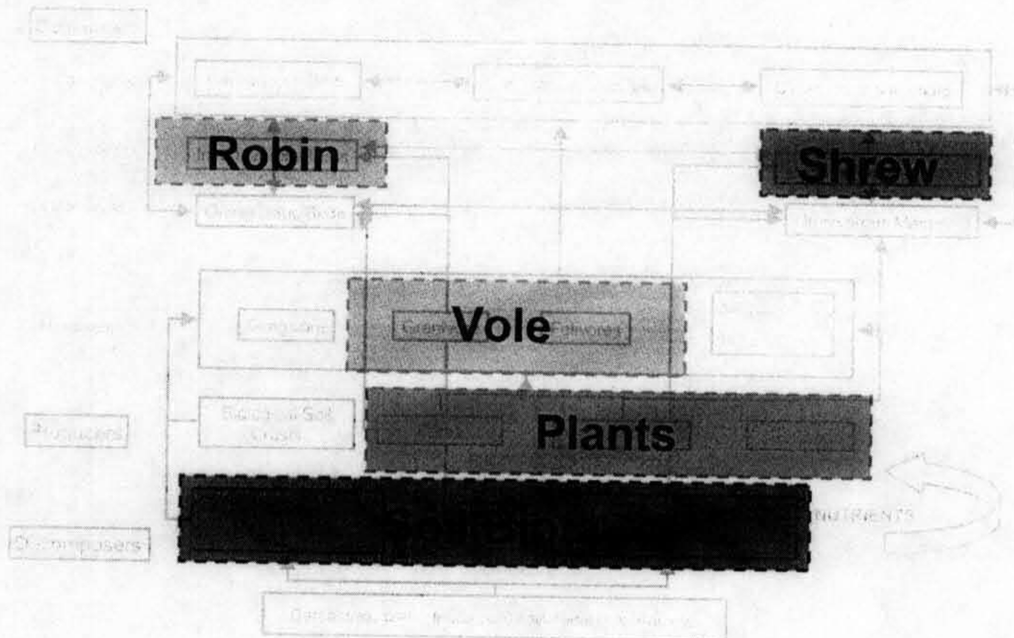


The Central Plateau food web is a simplification of the terrestrial ecosystem showing broad relationships limited to trophic transfer. One important simplification, such as depicting trophic-level relationships from a functional perspective, allows for ready identification of the feeding guilds most at risk from ingestion of contaminated plant and animal materials. The functional components of the ecosystem are defined on the basis of their role in the food web. These components, however, possess additional ecologically important attributes. For example, while shrubs may have leaves and seeds for food, they also provide structural habitat for nesting birds. And while nectar- and pollen-feeding animals may be relatively unimportant in terms of nutrient and energy transfer through the food web, they are important as plant pollinators. In evaluating potential AEs, adverse-effect potential is based on the toxicological characteristics of the COPECs, the sensitivity of the receptor, and the likely degree of exposure (WAC 173-340-7493(2), "Site-Specific Terrestrial Ecological Evaluation Procedures," "Problem Formulation Step").

4.3 WASHINGTON ADMINISTRATIVE CODE TERRESTRIAL ECOLOGICAL EVALUATION RECEPTORS

The WAC TEE receptors are superimposed on the Central Plateau food web as shown in Figure 4-2. The WAC TEE includes soil-screening values for terrestrial plants, soil biota, and wildlife (WAC 173-340-7490(3)(b), "Terrestrial Ecological Evaluation Procedures," "Goal").

Figure 4-2. Washington Administrative Code Terrestrial Ecological Evaluation Receptors. (WAC 173-340-900, Table 749-4)



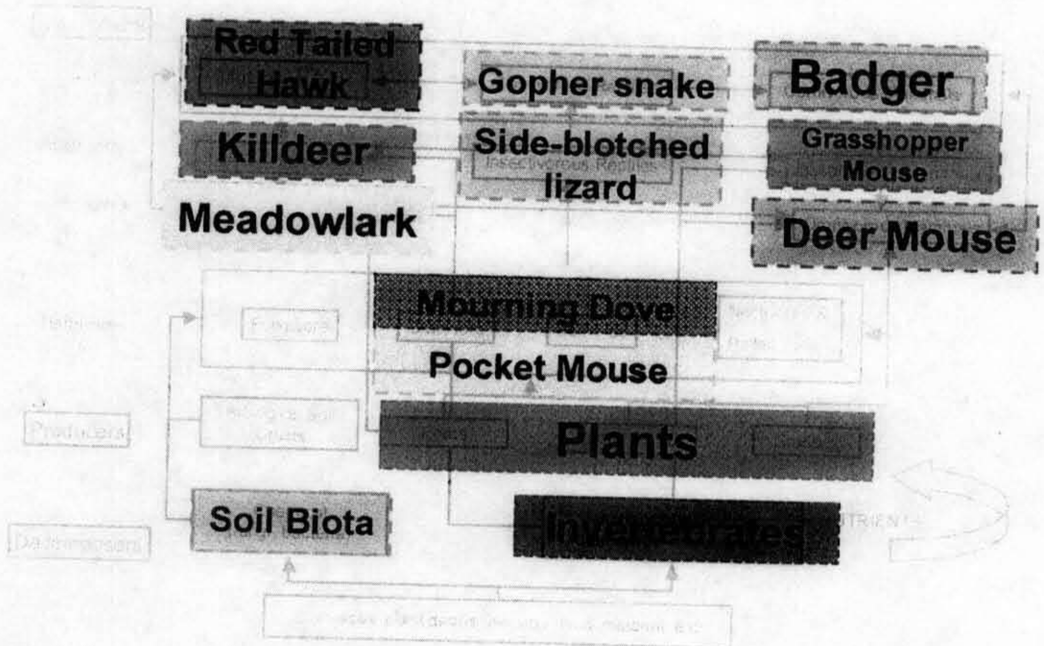
The specific language regarding soil biota is "…protectiveness is evaluated relative to plants, wildlife, and ecologically important functions of soil biota that affect plants or wildlife." This would imply that for soil biota, the process (e.g., organic matter decomposition or nutrient cycling) is more important than the receptor species; this is logical given the considerable functional redundancy in processes carried out by soil biota. The guidance also indicates (WAC 173-340-7493(7)(e), "Site-Specific Terrestrial Ecological Evaluation Procedures," "Substitute Receptor Species") that, unless there is clear and convincing evidence that they are not characteristic of the ecoregion where the site is located, the following groups should be considered in the wildlife exposure model: a small mammalian predator on soil-associated invertebrates, a small avian predator on soil-associated invertebrates, and a small mammalian herbivore, represented by the shrew, robin, and vole, respectively.

While shrews, robins, and voles may occur infrequently across the Central Plateau, it is important to note that they are conservative representatives of these feeding guilds. For example, the shrew's ingestion rate is 2.5 times greater than the ingestion rate of a more representative small mammal (deer mouse) of the Central Plateau (EPA/600/R-93/187a, *Wildlife Exposure Factors Handbook*); in other words, the shrew is exposed to 2.5 times more contaminants through the diet than a deer mouse would be. This is an adequate approach for the initial screening of site contaminants. However, the assessment incorporates greater ecological realism by using receptors characteristic of the arid Central Plateau for developing AEs and risk questions.

4.4 CENTRAL PLATEAU ECOLOGICAL EVALUATION RECEPTORS

Receptors suggested in the Central Plateau ecological evaluation (DOE/RL-2001-54, *Central Plateau Ecological Evaluation*) are presented in Figure 4-3. In addition to the soil biota's nutrient-cycling aspects, soil biota also are considered in terms of individual species in this receptor diagram; in other words, they are considered soil macroinvertebrates. Darkling beetles are abundant and important components of the Central Plateau food web (Rogers and Fitzner 1980, "Characterization of Darkling Beetles Inhabiting Radioecology Study Areas at the Hanford Site in Southcentral Washington"; Rogers et al. 1988, "Diets of Darkling Beetles (Coleoptera: Tenebrionidae) Within A Shrub-Steppe Ecosystem") and have been suggested to represent soil macroinvertebrates (DOE/RL-2001-54). Harvester ants also could serve as suitable surrogates for this trophic level. Plants could include many species, like Sandberg's bluegrass and big sagebrush, as representatives for primary producers.

Figure 4-3. Receptors Suggested in the Central Plateau Ecological Evaluation (DOE/RL-2001-54).



The Great Basin pocket mouse and the mourning dove can be considered the representative species for the mammalian and avian herbivores, respectively. The meadowlark and deer mouse can represent omnivores, insectivorous mammals can be represented by the grasshopper mouse, and insectivorous birds can be represented by the killdeer. Another insectivorous bird to consider is the sage sparrow. A suitable representative for insectivorous reptiles may be the side-blotched lizard. Selection of strict mammalian and avian insectivores is limited by animal abundance (e.g., grasshopper mouse represents <1 percent of small mammals [O'Farrell 1975, "Seasonal and Altitudinal Variations in Populations of Small Mammals on Rattlesnake Mountain, Washington"; O'Farrell et al., 1975, "A Population of Great Basin Pocket Mice

(*Perognathus Parvus*) in the Shrub-Steppe of South-Central Washington"]) and exposure potential (e.g., killdeer is a transient species). More importantly, however, considerable dietary overlap exists among the middle trophic levels, because all species are, to some degree, opportunists. For example, many species such as the sage sparrow are primarily insectivorous only at times when insects are abundant (WDFW 2003, *Washington Department of Fish and Wildlife's Priority Habitat and Species Management Recommendations, Vol IV: Birds – Sage Sparrow,* Amphispiza belli). It would be an artificial distinction to focus on a specific category, given the dietary overlap. Therefore, it may be more appropriate to consider herbivory, omnivory, and insectivory together for evaluating impacts on middle-trophic-level species.

Top carnivores can be represented by the gopher snake, red tailed hawk, and badger. In many cases, selection of an alternative representative for trophic categories may be perfectly appropriate. In selecting AEs for an ERA, it is important to realize that the selection of a particular species is less critical than the identification of the associated trophic category that may be at risk.

The assessment endpoints historically employed at the Hanford Site can be used to address management goals for the Central Plateau. For example, assessing effects on plants and soil biota will provide a basis for considering potential impacts on the plant and invertebrate new-to-science species (TNC 1999, *Biodiversity Inventory and Analysis of the Hanford Site, Final Report 1994-1999*). Also, the goal of maintaining the Central Plateau ecosystem health by maintaining soil fertility may be assessed through nutrient cycling carried out by soil biota. Evaluation of insectivorous birds assesses the potential impact of contaminants on special status species (migratory birds). And consideration of the food web from plants and soil biota up to carnivores evaluates the potential for bioaccumulation from COPECs. Finally, the overarching goal of an ERA is to protect and maintain healthy populations of ecological receptors (EPA 1999). Table 4-1 illustrates the link between management goals and nine proposed AE entities. The AE entities (listed in Table 4-1) can be represented by the receptors listed in Figure 4-3, as described in Table 4-2.

Assessment endpoints require more than specifying an entity to address management goals; attributes of the entity must be identified to facilitate the implementation of management goals. Lower trophic-level attributes of plants, soil biota, and soil macroinvertebrates could include survival, growth, and reproduction and the presence or absence of species, species diversity, primary and secondary productivity, decomposition, nutrient cycling, and respiration. Middle and upper trophic-level attributes of birds, mammals, and reptiles could include many of the same attributes and additional parameters like abundance, physical abnormalities, balanced gender ratios, and fledgling success and persistence (maintenance of a population for a period of time). Because the ultimate goal of an ERA is to protect and maintain healthy populations of ecological receptors (EPA 1999), attributes are selected based on relevance for population-level effects.

Table 4-1. Management Goals Addressed by Central Plateau Assessment Endpoint Entities.

Management Goals	Assessment Endpoints Entities								
	Plants	Soil Biota	Soil Macroinvertebrates	Herbivorous, Omnivorous, Insectivorous Birds	Insectivorous Reptiles	Herbivorous, Omnivorous, Insectivorous Mammals	Carnivorous Birds	Carnivorous Reptiles	Carnivorous Mammals
	AE1	AE2	AE3	AE4	AE5	AE6	AE7	AE8	AE9
Assess impacts on plants and invertebrates	+	+	+	-	-	-	-	-	-
Maintain soil fertility	+	+	+	-	-	-	-	-	-
Assess impacts on special status species	-	-	-	+	-	-	+	-	-
Minimize contaminant loading into biota	+	+	+	+	+	+	+	+	+
Protect populations of ecological receptors	+	+	+	+	+	+	+	+	+

Key:
"+" = assessment endpoint is applicable.
"-" = assessment endpoint is not applicable.
AE = assessment endpoint.

Table 4-2. Illustration of Central Plateau Assessment Endpoint Entities with Representative Ecological Receptors.

AE #	Central Plateau Assessment Endpoint Entity	Representative Central Plateau Ecological Receptors
AE1	Plants	All plants
AE2	Soil biota	Microbial processes
AE3	Soil macroinvertebrates	Darkling beetles, ants
AE4	Herbivorous, Omnivorous, Insectivorous Birds	Mourning dove, meadowlark, sage sparrow, killdeer
AE5	Insectivorous reptiles	Side blotched lizard
AE6	Herbivorous, Omnivorous, Insectivorous Mammals	Great Basin pocket mouse, deer mouse, grasshopper mouse
AE7	Carnivorous birds	Red tailed hawk, loggerhead shrike
AE8	Carnivorous reptiles	Gopher snake
AE9	Carnivorous mammals	Badger, coyote

AE = assessment endpoint.

4.5 ASSESSMENT ENDPOINT SYNOPSIS

The major points covered in Chapter 4.0 are as follows.

- Plants and soil macroinvertebrates are valuable AE entities because, considering the lack of inorganic trophic transfer, they potentially are more exposed indicators for evaluating adverse effects of inorganic COPECs.
- Central Plateau-specific receptors are suggested as ecological and societal relevant AEs.
- Central-Plateau-specific receptors are suggested as surrogates for the WAC 173-340-900, Table 749-4, feeding guilds, because they are at greater risk from COPECs in the toxicity evaluation. These feeding guilds include producers, soil biota, soil macroinvertebrates, middle-trophic-level vertebrates, and carnivorous reptiles, birds, and mammals.
- Draft AEs address management goals.
- Assessment endpoints will be measured directly or evaluated through use of surrogates as described in Chapter 7.0.

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5.0 CONCEPTUAL MODEL AND RISK QUESTIONS

The conceptual model summarizes the problem formulation results in terms of cause and effect relationships that link stressors to endpoint receptors. Understanding these relationships requires identifying the contaminated media that pose the greatest risk to terrestrial biota. The toxicity information developed through the COPEC refinement is used to set up a series of working hypotheses on how contaminant stressors might affect ecological components of the natural environment. Risk questions are presented as corollaries of COPEC refinement (including the toxicity evaluation) and AEs. General risk questions are included that address multiple specific AEs. In addition, risk questions are developed from participant input (January 29, 2004, EcoDQO workshop) to address resource injury concerns. The conceptual model and risk question information are applicable to all investigation phases.

The resource injury list was developed into attributes for describing ecological effects for Central Plateau receptors. Considering definitions of resource injury to soil (geologic) resources, effects are synonymous with what one would evaluate for lower biotic trophic levels (Figure 4-1) under ERAGS (EPA/540/R-97/006) and under the WAC's TEE process. Specifically, WAC 173-340-7490(3)(b) indicates that ecologically important functions of soil biota (i.e., soil processes) should be evaluated. Injury-related soil process effects include impedance of microbial respiration and inhibition of carbon mineralization; injuries to soil macroinvertebrates and plants simply involve toxicity. For upper trophic-level biological resources, injuries involve changes in viability. In an ERA context, the viability of a species typically is assessed with regard to impacts on reproduction, survival, and/or growth (EPA/540/R-97/006). Similarly, the goal of the WAC TEE is the protection of terrestrial ecological receptors from exposure to contaminated soil with the potential to cause significant adverse effects, where adversity is defined with regard to effects that impair reproduction, growth, or survival (WAC 173-340-7490(3)). These toxicological endpoints are addressed for plants, soil macroinvertebrates, birds, and mammals.

It is important to note, however, that while some biological resource injuries diverge from effects typically addressed in ERAs, these effects ultimately are captured as impacts on reproduction, survival, or growth. For example, the resource injuries of physical deformation, behavioral abnormalities, susceptibility to disease, and cancer ultimately could affect the viability of a species by reductions in the growth, survival, or reproductive output of impacted individuals; these latter endpoints are typically the focus of ERAs, because they are most directly linked to population-level effects.

The following section describes the link between the conceptual model and COPEC refinement and the selection of AE attributes for development into risk questions. In many cases, the justification for selecting an attribute is based on best professional judgment. The attributes and resulting risk questions are coded for easy association to proposed measures in later stages of the ERA.

5.1 ASSESSMENT ENDPOINT ONE (AE1): PLANTS

Conceptual Model and COPEC Refinement: Shallow soil has the greatest exposure potential. The inorganic COPECs in shallow soil exceed levels considered protective of plants. The plant attributes that were selected for development into risk questions are shown in Table 5-1.

Table 5-1. Plant Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Cover	Yes	Plant cover provides an easily measured metric of ecosystem and receptor characteristics for evaluating abundance of animals. Plant cover also provides a measure of effect for the plant community. However, this measure must be interpreted carefully, because some waste sites are generally managed for particular kinds of plant cover.
Reproduction	No	Not resource effective to measure because, compared to tests yielding comparable information, it is expensive to evaluate plant reproductive toxicity, given the time involved.
Presence/ absence	No	Not resource effective to measure (confounding effects may contribute to presence/absence, limiting data interpretability).
Species diversity	No	Not a direct population-level effect; consequently, information on this parameter is not amenable to effects assessment for a particular species. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors (e.g., invasion of non-native species like cheatgrass), which limits the utility of such data in interpreting contaminant effects.
Primary productivity	No	Not a direct population-level effect, consequently information on this parameter is not amenable to effects assessment for a particular species.

Plant Risk Question:

RQ1 Do COPECs in shallow zone soils decrease plant survival or growth?

5.2 ASSESSMENT ENDPOINT TWO (AE2): SOIL

Conceptual Model and COPEC Refinement: Shallow soil has the greatest exposure potential. WAC guidance on soil biota emphasizes ecologically important functions of soil biota, such as nutrient cycling aspects (WAC 173-340-7490(3)(b)). The soil biota attributes that were selected for development into risk questions are shown in Table 5-2.

Table 5-2. Soil Biota Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Decomposition	Yes	Ecosystem process that allows for nutrient recycling, resource-effective to measure.
Nutrient cycling	No	Not resource-effective. While the measure is not particularly expensive to run, it is relatively insensitive to contaminant impacts. Consequently, the information gained from this would be minimal.
Respiration	No	Not resource effective. While the measure is not particularly expensive to run, it is relatively insensitive to contaminant impacts, considering the functional redundancy of microbiota capable of mineralizing carbon compounds. Consequently, the information gained from this would be minimal.

Soil Biota Risk Question:

RQ2 Do COPECs in shallow zone soils affect decomposition by soil biota?

5.3 ASSESSMENT ENDPOINT THREE (AE3): SOIL MACROINVERTEBRATES

Conceptual Model and COPEC Refinement: Shallow soil has the greatest exposure potential. Soil-dwelling macroinvertebrates are fairly resistant to adverse effects of ionizing radiation (Gano 1981, "Mortality of the Harvester Ant (*Pogonomyrmex owyheei*) after Exposure to ^{137}Cs Gamma Radiation"; DOE-STD-1135-2002) and site risks likely are manifest as metal chemical toxicity. The soil macroinvertebrate attributes that were selected for development into risk questions are shown in Table 5-3.

Table 5-3. Soil Macroinvertebrate Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Species diversity	Yes	Although species diversity is not a population-level effect, because this does not readily translate into effects on a given species population, it does provide useful information on ecosystem characteristics. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors (e.g., invasion of non-native species like cheatgrass), which limits the utility of such data in interpreting contaminant effects. Relative diversity information can be collected readily by measuring the biomass of soil macroinvertebrates collected for tissue analysis into family-level groups.
Reproduction	No	Not resource effective to measure because, compared to tests yielding comparable information, it is expensive to run soil macroinvertebrate reproductive toxicity tests because of the time involved.
Secondary productivity	No	Not a direct population-level effect, because this does not readily translate into effects on a given species population.

Soil Macroinvertebrate Risk Question:

RQ3 Do COPECs in shallow zone soils affect soil macroinvertebrate survival or growth?

5.4 ASSESSMENT ENDPOINT FOUR (AE4): HERBIVOROUS, INSECTIVOROUS, OR OMNIVOROUS BIRDS

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. Relative to plants, inorganics have a greater propensity to accumulate in invertebrates. Consequently, insectivorous birds should be at greater risk than herbivorous or omnivorous birds. This avian AE also is used to evaluate bioaccumulation of COPECs in upper trophic levels, thus addressing the management goal concerned with contaminant loading in Central Plateau biota. The herbivorous, insectivorous, or omnivorous bird attributes that were selected for development into risk questions are shown in Table 5-4.

Table 5-4. Herbivorous, Insectivorous, or Omnivorous Bird Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Reproduction	Yes	Direct correlation to population-level effects.
Balanced gender ratios	Yes	Correlation to population-level effects.
Relative abundance (no./ha)	Yes	Correlation to population-level effects.
Physical abnormalities	No	Not a population-level effect. However, abnormalities noted as component of routine field data collection efforts.
Fledgling success	No	Field information on fledgling success will be collected if possible and evaluated for reproductive effects.
Species diversity	No	Not a population-level effect, because this does not readily translate into effects on a given species population. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors, which limits the utility of such data in interpreting contaminant effects.
Persistence	No	Not resource effective because of the time involved in following a species population over a long enough time frame to adequately quantify the perseverance of a species.
Biomass (kg/ha)	No	Not a direct measure of impacts on populations. Also, evaluating this attribute requires capturing and handling birds and, therefore, it was decided that this would an undesirable and unnecessary perturbing effect and that other less intrusive attributes can be measured.

Herbivorous, Insectivorous or Omnivorous Bird Risk Question:

RQ4 Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous bird survival, growth, reproduction or abundance, or affect balanced gender ratios?

5.5 ASSESSMENT ENDPOINT FIVE (AE5): INSECTIVOROUS REPTILES

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. Relative to plants, inorganics have a greater propensity to accumulate in invertebrates. Consequently, insectivorous reptiles could be at risk. This insectivorous reptile AE also is used to evaluate bioaccumulation of COPECs in middle trophic levels, thus addressing the management goal concerned with contaminant loading in Central Plateau biota. The insectivorous reptile attributes that were selected for development into risk questions are shown in Table 5-5.

Table 5-5. Insectivorous Reptile Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Relative abundance (no./ha)	Yes	Correlation to population-level effects.
Biomass (kg/ha)	Yes	Noted as component of routine field data collection efforts.
Size structure (snout-vent length)	Yes	Noted as component of routine field data collection efforts. Provides information on population size structure.
Physical abnormalities	No	Not a population-level effect. However, abnormalities noted as component of routine field data collection efforts.
Survival	No	Not resource effective, because literature studies are not available to determine adverse-effect levels on reptiles, and special studies would be required.
Growth	No	Not resource effective, because literature studies are not available to determine adverse-effect levels on reptiles, and special studies would be required.
Reproduction	No	Not resource effective, because literature studies are not available to determine adverse-effect levels on reptiles, and special studies would be required.
Balanced gender ratios	No	Not resource effective, because it is difficult to determine the gender of reptiles in the field.

Insectivorous Reptile Risk Question:

RQ5 Do COPECs in shallow zone soils and food decrease insectivorous reptile abundance or biomass, or affect size structure?

5.6 ASSESSMENT ENDPOINT SIX (AE6): HERBIVOROUS, INSECTIVOROUS, OR OMNIVOROUS MAMMALS

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. Relative to plants, inorganics have a greater propensity to accumulate in invertebrates. Consequently, insectivorous mammals should be at greater risk than herbivorous or omnivorous mammals. Although large herbivores are generally most sensitive to radiation effects, the next most sensitive group includes small mammals (PNL-9394, *Ecotoxicity Literature Review of Selected Hanford Site Contaminants*). The herbivorous, insectivorous, or omnivorous mammal AE also is used to evaluate bioaccumulation of COPECs in upper trophic levels, thus addressing the management goal concerned with contaminant loading in Central Plateau biota. The herbivorous, insectivorous, or omnivorous mammal attributes that were selected for development into risk questions are shown in Table 5-6.

Table 5-6. Herbivorous, Insectivorous, or Omnivorous Mammal Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Reproduction	Yes	Direct correlation to population-level effects.
Balanced gender ratios	Yes	Correlation to population-level effects.
Relative abundance (no./ha)	Yes	Correlation to population-level effects.
Biomass (kg/ha)	Yes	Noted as component of routine field data collection efforts.
Physical abnormalities	No	Not a population-level effect. However, abnormalities noted as component of routine field data collection efforts.
Species diversity	No	Not a population-level effect, because this does not readily translate into effects on a given species population. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors, which limits the utility of such data in interpreting contaminant effects.
Persistence	No	Not resource effective because of the time involved in following a species population over a long enough time frame to adequately quantify the perseverance of a species.

Herbivorous, Insectivorous or Omnivorous Mammal Risk Question:

RQ6 Do COPECs in shallow zone soils and food decrease herbivorous, insectivorous, or omnivorous mammal survival, growth, reproduction, abundance, or biomass or affect balanced gender ratios?

5.7 ASSESSMENT ENDPOINT SEVEN (AE7): CARNIVOROUS BIRDS

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. The carnivorous bird attributes that were selected for development into risk questions are shown in Table 5-7.

Table 5-7. Carnivorous Bird Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Reproduction	Yes	Direct correlation to population-level effects.
Species diversity	No	Not a population-level effect, because this does not readily translate into effects on a given species population. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors, which limits the utility of such data in interpreting contaminant effects.
Balanced gender ratios	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Abundance (no./ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Biomass (kg/ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Physical abnormalities	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Persistence	No	Not resource effective because of the time involved in following a species population over a long enough time frame to adequately quantify the perseverance of a species.

Carnivorous Bird Risk Question:

RQ7 Do COPECs in shallow zone soils and food decrease carnivorous bird survival, growth, or reproduction?

5.8 ASSESSMENT ENDPOINT EIGHT (AE8): CARNIVOROUS MAMMALS

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. The carnivorous mammal attributes that were selected for development into risk questions are shown in Table 5-8.

Table 5-8. Carnivorous Mammal Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Survival	Yes	Direct correlation to population-level effects.
Growth	Yes	Direct correlation to population-level effects.
Reproduction	Yes	Direct correlation to population-level effects.
Species diversity	No	Not a population-level effect, because this does not readily translate into effects on a given species population. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors, which limits the utility of such data in interpreting contaminant effects.
Balanced gender ratios	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Abundance (no./ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Biomass (kg/ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Physical abnormalities	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Persistence	No	Not resource effective because of the time involved in following a species population over a long enough time frame to adequately quantify the perseverance of a species.

Carnivorous Mammal Risk Question:

RQ8 Do COPECs in shallow zone soils and food decrease carnivorous mammal survival, growth, or reproduction?

5.9 ASSESSMENT ENDPOINT NINE (AE9): CARNIVOROUS REPTILES

Conceptual Model and COPEC Refinement: Of shallow soil pathways, ingestion represents the most significant exposure route. The carnivorous reptile attributes that were considered for development into risk questions are shown in Table 5-9. In general, reptiles lack toxicity reference values, and this obviates our ability to infer effects from exposure dose or tissue concentration data. In addition, carnivorous reptiles, like other carnivores, are relatively scarce (compared to lower and middle-trophic-level receptors) on the Central Plateau. To make any conclusions about potential effects of COPECs, a tremendous effort would be required to collect enough specimens. Considering the logistical constraints associated with this AE, it is unrealistic to propose carnivorous reptiles as subjects for further investigation. However, this feeding guild can be assessed in the uncertainty analysis in comparison to calculated risks for other carnivores.

Table 5-9. Carnivorous Reptile Attributes Selected for Development into Risk Questions.

Attribute	Select	Justification
Species diversity	No	Not a population-level effect, because this does not readily translate into effects on a given species population. Species diversity is unlikely to provide definitive data on contaminant impacts, considering that the initial focus is on waste sites, and waste sites are basically wheatgrass monocultures. Also, species diversity may be influenced by a number of noncontaminant stressors, which limits the utility of such data in interpreting contaminant effects.
Survival	No	Not resource effective, given the basic research required to correlate toxicant effects of COPECs on survival.
Growth	No	Not resource effective, given the basic research required to correlate toxicant effects of COPECs on growth.
Reproduction	No	Not resource effective, given the basic research required to correlate toxicant effects of COPECs on reproduction.
Balanced gender ratios	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Abundance (no./ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Biomass (kg/ha)	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Physical abnormalities	No	Not resource effective, given the scale and associated efforts for collecting meaningful information (few individuals over large areas).
Persistence	No	Not resource effective because of the time involved in following a species population over a long enough time frame to adequately quantify the perseverance of a species.

COPEC = contaminant of potential ecological concern.

Carnivorous Reptile Risk Question:

RQ9 Not applicable, because no attribute will be developed into a risk question.

5.10 CONCEPTUAL MODEL AND RISK QUESTIONS SYNOPSIS

The major points covered in Chapter 5.0 are as follows.

- The draft risk questions are a logical outcome of COPEC refinement and consideration of AE attributes.
- The selection of attributes for development into risk questions is clearly justified.
- The draft risk questions are presented from an ERA remedial investigation perspective and from a resource injury perspective; the remedial investigation-specific questions are generally comprehensive of resource injury concerns.
- The draft risk questions represent the conceptual model of how contaminant stressors are most likely to impact the Central Plateau ecosystem.
- Risk questions are posed to identify measures of effect, exposure, and ecosystem/receptor characteristics.

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6.0 SCIENTIFIC MANAGEMENT DECISION POINT FOR PROBLEM FORMULATION

In summary, the problem formulation step of an ERA is described. Problem formulation represents a refinement of the initial conceptual model of the screening assessment. Conceptual models are based on contaminated media, and all potential exposure routes are evaluated to identify the contaminated medium of greatest exposure potential for terrestrial biota. Data then are reviewed to identify the COPECs from that medium. In addition, the relationships between contaminant stressors and endpoint receptors are developed into a set of working hypotheses on how the stressor might affect ecological components of the natural environment. These hypotheses are the risk questions that are used to identify the data needed to support the ERA and subsequent remedial action decision making. These information needs are satisfied through a SAP that is developed based on the study design described in the subsequent sections of the EcoDQO document. In transitioning to the next phase of the EcoDQO (ERAGS Step 4; Figure 1-2), concerns over the ERAGS Step 3 scientific management decision points synopsized in Chapters 2.0 through 5.0 are addressed.

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7.0 MEASURES

The framework for ecological measures is derived from EPA/630/R-95/002F. Data collection efforts will address measures of effect, measures of ecosystem and receptor characteristics, and measures of exposure and may include field, laboratory, and model data. The measures that address risk questions for Hanford Site-specific AEs are presented in Table 7-1. These measures are planned or are to be considered for Phases I, II, or III. These measures will provide multiple lines of evidence to assess the adverse effects from site COPECs. The following section links AE risk questions to appropriate ecological measures to address the question (Table 7-2).

These measures either will support the ecological screening assessment (DOE/RL-2001-54) (e.g., through collection of additional soil data), or will add site specificity to initial risk assumptions. The degree of conservatism in the screening assessment is reduced with increased ecological realism provided in this stage of an ERA (Fairbrother 2003, "Lines of Evidence in Wildlife Risk Assessments"). For example, initial assumptions of 100 percent bioavailability will be reassessed with direct measures of concentrations of contaminants in wildlife diet items (plants and macroinvertebrates) and in wildlife tissue concentrations. This measure eliminates the imprecision inherent in literature-derived trophic transfer factors (e.g., WAC 173-340-900, Table 749-5) and also directly assesses variations in site-specific bioavailability (Fairbrother 2003).

7.1 MEASURES SYNOPSIS

Measures of effect, exposure, and receptor/ecosystem characteristics were selected. These measures form the basis of the data needs for the study design. Figure 7-1 illustrates the species included for direct measures (e.g., measure abundance or tissue residues), which potentially include all lower and middle trophic-level assessment-endpoint feeding guilds with the exception of insectivorous mammals and birds represented by the grasshopper mouse and killdeer. It is unlikely that sufficient numbers of grasshopper mouse and killdeer will be available for any direct measures. Risk for the upper trophic-level species will be evaluated indirectly (through information on their food and no-adverse-effect levels). Recall that risk on upper trophic-level reptiles only will be evaluated qualitatively because of a lack of TRVs for reptiles.

Table 7-1. Proposed Measures of Exposure, Effect, and Ecosystem/Receptor Characteristics.

Code	Measure
Measures of Exposure	
M1	COPEC concentration in soil
M2	COPEC concentration in biota tissue
Measures of Effect	
M3	Laboratory toxicity testing
M4	Comparison of COPEC concentrations in soil to literature-derived adverse-effect level for plants and invertebrates in soil
M5	Modeled extrapolation of COPEC concentrations in soil to literature-derived adverse-effect level for diet (wildlife only)
M6	Comparison of COPEC concentrations in tissue to literature-derived adverse-effect level for assessment endpoint tissue concentration (wildlife only)
M7	Field study of potential for adverse effects (conditional on field verification efforts)
Ecosystem/receptor characteristics	
M8	Habitat types

COPEC = contaminant of potential ecological concern.
M = measure.

Table 7-2. Proposed Measures to Assess Adverse Effects in Central Plateau Assessment Endpoints. (2 Pages)

Risk Question (from Chapter 5.0)	Assessment Endpoint Attributes	M1: COPEC in Soil	M2: COPEC in Biota	M3: Toxicity Testing	M4: Compare COPEC in Soil to BCG	M5: Compare Modeled COPEC Exposure to SSV	M6: Tissue concentration Effects	M7: Field Study	M8: Habitat Type
Plants (AE1)									
RQ1	Survival, growth	+	+	+	+	-	-	-	+
Soil Biota (AE2)[1]									
RQ2	Decomposition	+	-	-	-	-	-	+[1]	+

Table 7-2. Proposed Measures to Assess Adverse Effects in Central Plateau Assessment Endpoints. (2 Pages)

Risk Question (from Chapter 5.0)	Assessment Endpoint Attributes	M1: COPEC in Soil	M2: COPEC in Biota	M3: Toxicity Testing	M4: Compare COPEC in Soil to BCG	M5: Compare Modeled COPEC Exposure to SSV	M6: Tissue concentration Effects	M7: Field Study	M8: Habitat Type
Soil Macroinvertebrates (AE3)									
RQ3	Survival, growth	+	+	+	+	-	-	-	+
Herbivorous, Insectivorous or Omnivorous Birds (AE4)[2]									
RQ4	Survival, growth, reproduction	+	+	-	-	+	+	-	+
	Balanced gender ratios, abundance	+	+	-	-	-	-	+	+
Insectivorous Reptiles (AE5)[3]									
RQ5	Abundance, biomass, snout-vent length	+	+	-	-	-	-	+	+
Herbivorous, Insectivorous or Omnivorous Mammals (AE6)[4]									
RQ6	Survival, growth, reproduction	+	+	-	-	+	+	-	+
	Balanced gender ratios, abundance, biomass	+	+	-	-	-	-	+	+
Carnivorous Birds (AE7)[5]									
RQ7	Survival, growth, reproduction	+	+	-	-	+	+	-	+
Carnivorous Mammals (AE8)[6]									
RQ8	Survival, growth, reproduction	+	+	-	-	+	+	-	+

Key:
"+" = measure is applicable.
"-" = measure is not applicable.
AE = assessment endpoint.
COPEC = contaminant of potential ecological concern.
M = measure.
RQ = risk question.
SSV = soil-screening value.

[1] Conditional on field verification for applicability of soil litterbag studies to assess adverse COPEC effects on decomposition.

[2] COPEC concentrations in biota are based on nonviable eggs. Modeled exposure estimate based on COPEC concentrations in plants and/or prey. Observation of fledglings in nest will provide information on reproduction (fledgling success) and observation of physical abnormalities proposed as a component of routine field work but conditional on field verification activities.

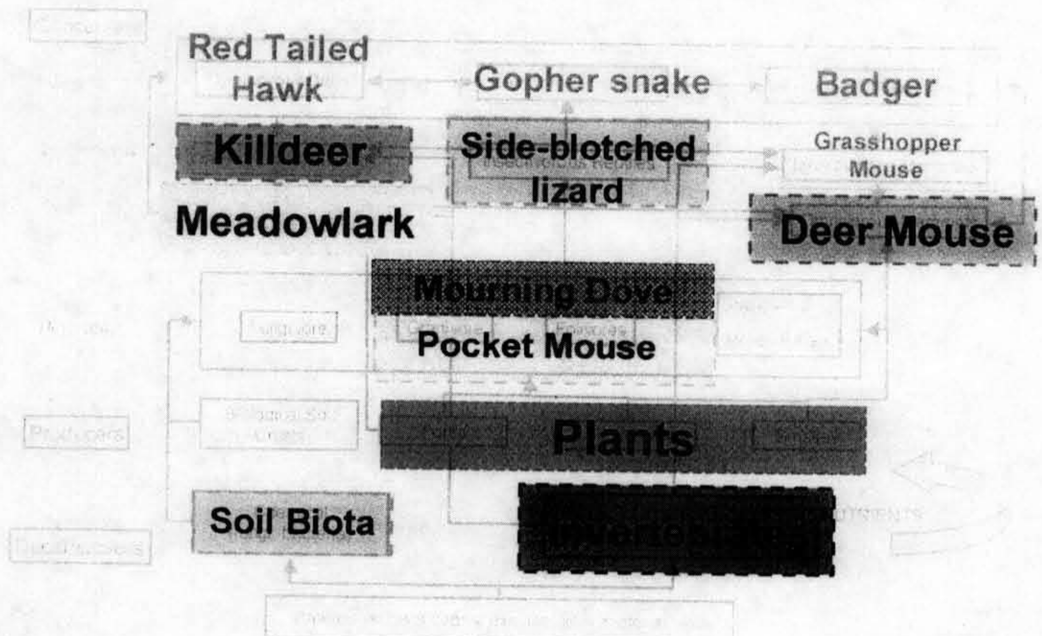
[3] Modeled exposure estimate could be based on COPEC concentrations in prey, but lack of reptile toxicity benchmarks makes this exercise impractical. Observation of physical abnormalities proposed as a component of routine field work but conditional on field verification activities.

[4] COPEC concentrations in biota are based on whole-body analysis. Modeled exposure estimate based on COPEC concentrations in plants and/or prey. Observation of physical abnormalities proposed as a component of routine field work but conditional on field verification activities.

[5,6] Modeled exposure estimate based on COPEC concentrations in prey.

Figure 7-1. Assessment Endpoint Receptors with Species Proposed for Direct Measures Highlighted.

(Effects on gray-shaded receptors are evaluated indirectly.)



8.0 DATA QUALITY OBJECTIVES AND STATISTICAL CONSIDERATIONS

ERAGS and the DQO process offer two complementary approaches to developing SAPs. The DQO process is general and can be applied to any environmental problems. DQO Steps 1 and 2 ("state the problem" and "identify the decision") were considered in ERAGS Step 3 or problem formulation. The parts of the DQO process that complement the ERAGS study design include DQO Steps 3 through 6, which include "identify the inputs to the decision" (or ERAGS measures), "define the study boundaries," "develop a decision rule," and "limits on decision errors." DQO Step 7, "develop and optimize the design for collecting data," is started during ERAGS study design and is completed during ERAGS field verification (Step 5). DQOs are developed for Phases I, II, and III.

8.1 BOUNDARIES

Relevant ecological spatial boundaries are the areas encompassed by individuals and populations and the depth of biological activity. Information on receptors considered representative of the AEs is summarized in Table 8-1 and includes information on home range, dispersal distance, minimum critical patch size, population density, and assessment population area.

Home range is defined in terms of how individuals use the environment for breeding or feeding. Table 8-1 shows that the area of home range for Central Plateau ecological receptors varies between 0.1 and 1,800 ha. Figure 8-1 shows that there is a positive correlation between body weight and home range (meaning that larger animals require larger home ranges) and that there is a negative correlation between population density and body weight (meaning larger animals are less common). Population density information is an important consideration when selecting species to evaluate measures of effect and exposure. Some species are clearly predicted to be abundant on a hectare (e.g., Great Basin pocket mouse, side-blotched lizard), while others are vanishingly rare on a hectare (e.g., red-tailed hawk). Home range is used to calculate area-use factors (AUF) for individual ecological receptors, where AUFs are the ratio of the contaminated site area to the receptor's home range (EPA 2003a, *Guidance for Developing Ecological Soil Screening Levels*, OSWER 9285.7-55).

While effects on individuals need to be considered (especially for protected species) in an ERA, as stated in Section 4.1, the primary ecological risk management goal for CERCLA is the protection and maintenance of healthy populations of ecological receptors (EPA 1999). Consequently, information is needed on the area that populations encompass to assess population-level impacts. Specifically, population AUFs can be used to calculate COPEC exposure estimates for populations of ecological receptors.

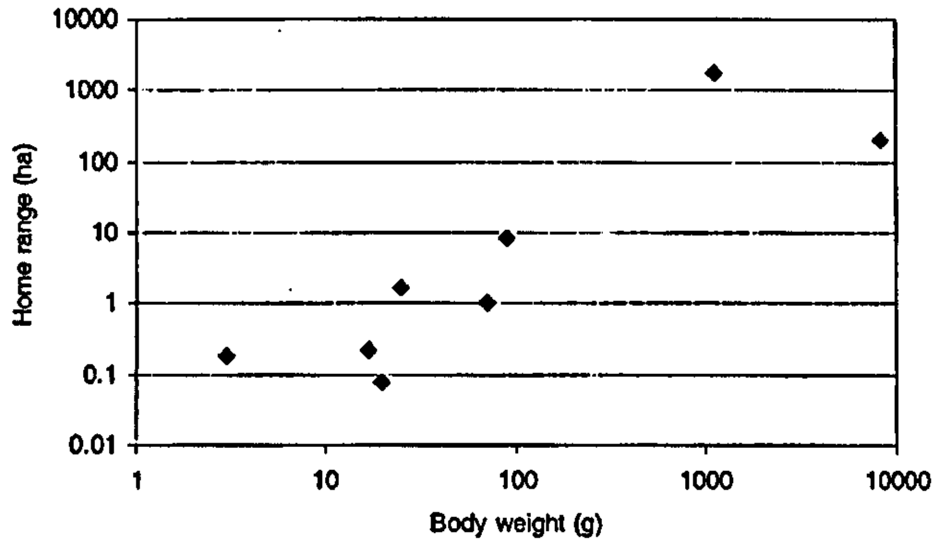
Table 8-1. Spatial and Other Receptor Information for Species Considered as Assessment Endpoint Representatives.

Guild	Class	Scientific Name	Common Name	Body Weight (male, female) (g)	Home Range (ha)	Median Dispersal Distance (male, female) (km)	Maximum Dispersal Distance (male, female) (km)	Minimum Critical Patch Size (ha)	Population Density (No./ha)	Assess Population Area (ha)
Herbivore	Mammal	*Perognathus parvus*	Great Basin pocket mouse	(18, 16)	(0.05, 0.4)	NA	NA	NA	118	9
Herbivore	Bird	*Zenaida macroura*	Mourning dove	125	NA	NA	4.8	NA	3	NA
Insectivore	Mammal	*Onychomys leucogaster*	N. grass-hopper mouse	(24, 26)	1.725	NA	NA	NA	1	69
Insectivore	Bird	*Charadrius vociferous*	Killdeer	70	1	11.8	(596, 146)	NA	0.9	40
Omnivore	Mammal	*Peromyscus maniculatus*	Deer mouse	(20, 19)	0.077	(0.05, 0.15)	(0.883, 1.005)	NA	6	3.08
Omnivore	Bird	*Sturnella neglecta*	Western meadowlark	(102, 76)	8.5	NA	NA	25	0.3	340
Carnivore	Mammal	*Taxidea taxus*	Badger	8250	200	NA	110, 52	7000	NA	8000
Carnivore	Bird	*Buteo jamaicensis*	Red Tailed hawk	(1063, 1204)	1770	NA	NA	NA	0.0002	70800
Carnivore	Reptile	*Uta stansburiana*	Side-blotched lizard	3	0.175	NA	NA	NA	104	7

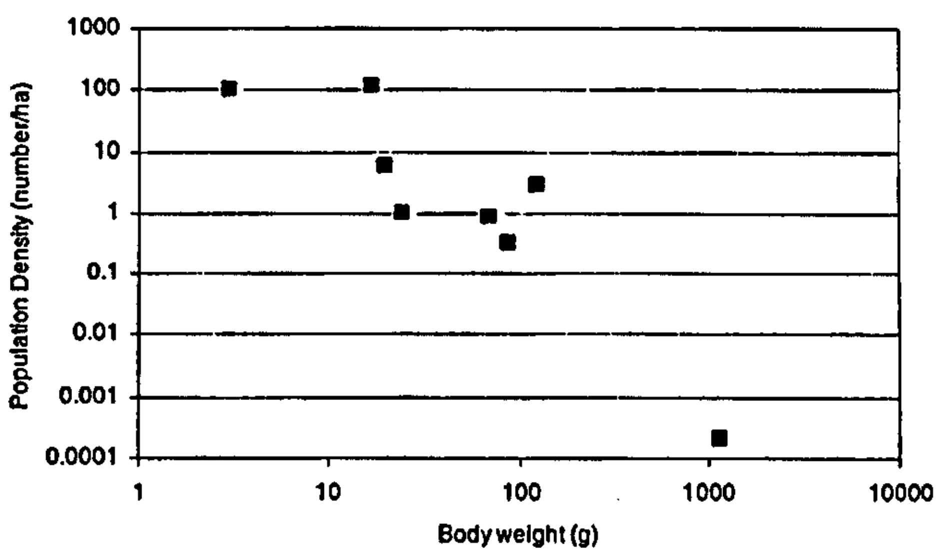
Note = 1 ha = 2.47 acres.
NA = not applicable.

Figure 8-1. Relationship between Body Weight and Home Range or Density.

(a)



(b)



Wildlife assessment population boundaries can be based on a receptor's dispersal distance (Ryti et al. 2004, "Preliminary Remediation Goals for Terrestrial Wildlife"); for mammals, dispersal distance is strongly related to the linear dimension (square root) of home range. Dispersal distance provides a measure of the distance that animals may travel and therefore is an indicator of gene flow -- an important consideration in defining a biological population. Information on dispersal distance is available from Bowman et al. 2002, "Dispersal Distance of Mammals is Proportional to Home Range Size" for mammals and from Sutherland et al. 2000, "Scaling of Natal Dispersal Distances in Terrestrial Birds and Mammals," for birds.

Assuming that wildlife are unlikely to disperse beyond some distance from their birth or natal site, dispersal distance can be thought of as the radius (r) of the assessment population's boundaries. Considering the population boundary as circular, it can be spatially defined by calculating the area of a circle (πr^2). Operationally, an assessment population is defined as the individuals within the area calculated from a receptor's (e.g., pocket mouse) dispersal distance. This general relationship is useful as a simple way to estimate assessment population areas for terrestrial animals and helps fill data gaps for wildlife without direct measurements of dispersal. Ryti et al. 2004 have shown that the assessment population area can be defined as 40 times the home range. For Central Plateau ecological receptors, the assessment population area varies between 3 and 70,000 ha (Table 8-1).

The minimum critical patch size is another measure of the area needed to maintain an animal population, and it varies between 25 and 7,000 ha (Carlsen et al. 2004, "The Spatial Extent of Contaminants and the Landscape Scale: An Analysis of the Wildlife, Conservation Biology, and Population Modeling Literature"), but minimum critical-patch size information is only available for two receptors (killdeer and badger). Minimum critical patch sizes for these animals are reasonably consistent with the estimated assessment population areas (killdeer critical patch is 10 times smaller than the assessment population area; badger critical patch is roughly equal to the assessment population area). The important observation from this spatial scale information is that ecological receptors and populations interact with the environment over a scale on the order of a single hectare to thousands of hectares. Thus, 1 ha is a reasonable minimum area to consider for averaging wildlife exposure. This area also is reasonable for invertebrates, but clearly individual plants interact with contaminated soil on a smaller spatial scale. In contrast to the 1 ha scale, the BC Controlled Area is approximately 3,471 ha in area, and the Central Plateau Core Zone is about 5,800 ha.

Ecological receptors interact with the environment over various lateral spatial scales, and this information is useful for understanding how COPECs might bioaccumulate in various species. As discussed in Section 2.1, biological activity also varies with soil depth through the shallow zone (0-4.6 m [0-15 ft] soil interval). However, exposure does not occur uniformly over this 4.6 m (15-ft) interval. The ground surface represents one important direct exposure medium for wildlife. Plants and burrowing animal activity vary with depth, and there is less activity with depth from the surface down through the shallow zone (Figure 2-3). Thus, there is a rationale for focusing data collection and assessment of more surficial soils (those in the zone of greater biological activity or the top 1.8 m [6 ft]).

8.2 DECISION RULES (RISK QUESTIONS)

Decision rules or risk questions used for ecological risk characterization support a weight-of-evidence evaluation of the potential for ecological risk. The following risk questions have been developed to determine if COPECs on soil adversely affect the AEs. Thus, decision rules are developed for measures of effect. The risk questions are stated generically for a receptor, with receptors replaced by the relevant measure species for each AE. An exception is risk question #2, which is specific for soil biota and their role in nutrient cycling. All of the risk questions are based on a design with a reference site and a COPEC gradient.

1. Is the contribution to the SOF based on mean concentrations greater than 1 and also greater than the SOF based on mean concentrations for the reference site (or the SOF based on background mean concentrations)?

2. Does mean survival or growth of receptor decrease from those in the reference soil or along a gradient of increasing COPEC concentrations? (AE1, AE3)

3. Do mean rates of nutrient cycling for soil biota decrease from those in the reference soil or along a gradient with increasing COPEC concentrations? (AE2)

4. Does population abundance of receptor decrease from those in the reference site or along a gradient with increasing COPEC concentrations for the same habitat type? (AE4, AE5, AE6)

5. Do receptor reproductive rates decrease from those in the reference site or along a gradient with increasing COPEC concentrations for the same habitat type? (AE4, AE6)

6. Do receptor gender ratios deviate from equality in comparison to the reference site or along a gradient with increasing COPEC concentrations for the same habitat type? (AE4, AE6)

7. Do mean COPEC concentrations in the receptor increase compared to mean concentrations in reference site receptors or along a gradient with increasing COPEC concentrations (greater than published levels associated with toxicity)? (AE1, AE3, AE4, AE5, AE6)

8. Do mean COPEC concentrations in receptor diet increase from those in the reference site or along a gradient with increasing COPEC concentrations (greater than TRV)? (AE4, AE5, AE6, AE7, AE8)

Risks will be characterized based on the answers to these questions, and the answers to questions 2-8 will either refute or confirm the answer to question 1 (screening-level risk characterization). If the answer from more than one question is used to characterize ecological risks, then it is necessary to rank the lines of evidence in their importance to characterizing ecological risks. This is necessary to break ties between lines of evidence that may have contradictory conclusions. For the lower and upper trophic levels and middle trophic-level reptiles (AE1, AE2, AE3, AE5, AE7, AE8), risks will be characterized, with one question for each assessment endpoint (although not the same question for each endpoint). Risks to the middle trophic-level bird and mammal assessment endpoints (AE4, AE6) will be assessed by multiple questions, which serve to emphasize the relative importance of the middle trophic levels to this ecological risk assessment. Inferences on the ecological effects on middle trophic-level birds and mammals are made based on differences in field measures of abundance, reproduction, and skewed gender ratios (risk questions #4, 5, 6) or a combination of animal/diet concentrations and the literature adverse-effect levels (risk questions #7, 8). Because animal abundance fluctuates greatly, less credence will be afforded to differences based on abundance, compared to reproduction or skewed gender ratios. Skewed gender ratios and reproduction will be given equal weight in terms of evaluating adverse effects. Field measures (risk questions #4, 5, 6) will be given greater weight than measures, depending on literature toxicity data (risk questions #7, 8).

8.3 LIMITS OF DECISION ERRORS

As discussed in Section 8.2, the decision rules for this assessment are being evaluated using a weight- (or strength-) of-evidence approach. This is particularly true for the middle trophic-level birds and mammals that are the focus of this assessment. Because uncertainty will be evaluated in a qualitative manner in this weight-of-evidence approach, a judgmental basis is selected for the study design. While limits on decision errors will be qualitative, some aspects of the study design will benefit from randomization (e.g., selection of some sample locations, randomization of test organisms to treatments). Data also will be evaluated for statistical trends, and significance will be determined by probabilities of 0.05 or less; in addition, the upper confidence level of the mean values will be used in calculating exposure and doses.

8.4 DATA QUALITY OBJECTIVES AND STATISTICAL CONSIDERATIONS SYNOPSIS

- The spatial boundaries for the receptors considered to be representative of the Central Plateau terrestrial AEs suggest that 1 ha is an appropriate scale for assessing ecological risks.
- Decision rules were developed to evaluate the various measures and AEs under consideration for the Central Plateau ecological risk investigations.

9.0 STUDY DESIGN

A synopsis of the proposed study design is provided in Table 9-1; it shows how the various data types (measures) relate to risk questions, the key features of the study design, and the basis for the design element. All aspects of the study design are subject to field verification, which may require selecting alternate measures for an AE or other modifications to the study design (e.g., plot size, trapping density). Data will be collected in three phases to evaluate ecological risks (Table 9-1). A tiered approach to data collection is employed, because advanced stages of sampling will be based on the results of initial collection efforts.

Using a phased approach to characterize ecological risks has the advantage of targeting data collection to those ecological receptors found to be at risk from Hanford Site processes and waste sites and the associated COPECs. Phasing also allows for testing aspects of the conceptual model that were used to develop the overall design. One key aspect of the conceptual model is the list of COPECs, which are based on existing sample data and process knowledge. Sampling for contaminants of interest can help to verify this aspect of the conceptual model.

Another important component of the conceptual model is the primary exposure medium, including the depth of biological activity. Data suggest that surface soil is important as an exposure medium for direct contact with wildlife, root uptake, and animal burrowing. Thus, surface samples (of 15 cm [6 in.]) can be collected, along with specific biological samples, to test for COPEC uptake. Collecting surface soil samples for the initial data collection activities has important practical advantages. Methods for collecting surface soil samples are less intrusive than those needed for deeper soil characterization (e.g., truck-mounted drill rigs) and, therefore, minimize the impacts of data collection on the shrub-steppe ecosystem. The conceptual model of possible downward mobility of surficially-deposited radionuclides (e.g., through animal-induced soil turnover and meteoric water input) will be assessed by comparing areas representing primarily subsurface-soil (e.g., ant mounds and mammal burrow spoils) relative radioactivity levels in topsoil through radiological field data collection.

The specific receptors targeted for initial sampling are mammals, lizards, and soil macroinvertebrates, because these organisms were viewed as having a high potential to accumulate site COPECs. Plant tissue initially will be assessed for radionuclide uptake using radiological field data on gamma-emitting radionuclides. To help address trustee information needs, abnormalities will be noted on any animals handled during data collection. Additional data collection is dependent on the results of the initial investigation phases and may include characterization of soils deeper than 15 cm (6 in.), plant tissue concentrations, population measures for mammals and lizards, field verification for middle trophic-level birds, litterbag studies, and toxicity tests for plants and invertebrates.

As indicated in Chapter 1.0, Phase I activities are focused on the 200 East and 200 West Areas in the industrialized Core Zone; Phase II expands consideration of sampling to US Ecology and Office of River Protection sites in the Core Zone and the BC Controlled Area; and Phase III includes habitat outside of the 200 East and 200 West Areas. Phase I and II data collection will be followed by a Phase III data quality assessment (DQA), and subsequent investigations in Phase III will be dependent on the results of the DQA.

Table 9-1. Central Plateau Ecological Data Quality Objective Sampling Design Summary Table Linking Proposed Measures to Risk Questions. (2 Pages)

Phase[a]	Data Type	Risk Question (Chapter 5.0)	Sample Population	Key Features of Design	Basis for Study Design
I, II, III	Radiological field survey data for gamma-emitting radionuclides	All risk questions are dependant on soil data; because this is a precursor to soil collection, it affects all risk questions.	Waste-site soils and plant material	Used before soil sampling was performed.	Supports testing of the conceptual model of biological transport and allows an assessment of areas of elevated radioactivity.
I, II, III	Plant cover estimation	RQ1, RQ3, RQ4, RQ5	Waste-site and reference site plants	Provides a measure of effect for the plants and a measure of ecosystem characteristics for animals	Supports evaluation of animal abundance and provides a measure of habitat quality
I, II, III	Surface soil sampling	All risk questions will employ these data	Waste-site and reference site soils	Multi-increment samples representing 0 to 15 cm (0 to 6 in.).	Multi-increment samples for estimate of average exposure over sampling area.
III	Soil sampling	All risk questions will employ these data.	Waste-site and reference site soils	Grab and multi-increment samples stratified over 0 to 1.8 m (0 to 6 ft) (representing 0 to 15 cm [0 to 6 in.], and deeper intervals).	Grab samples collocated with plant tissue for waste-site specific uptake estimates. Multiincrement samples for estimate of average exposure over sampling area.
I, II, III	Biota tissue sampling	RQ1, RQ3, RQ4, RQ5, RQ6, RQ7, RQ8	Plants, invertebrates caught in pitfall traps, ground-nesting bird eggs, small mammals, lizards	Composite for plant vegetative and reproductive parts separately. For invertebrates, composite of pitfall trap contents. For birds, nonviable eggs of second clutch used. For reptiles and mammals, individual animals.	Initial comparisons of COPECs in biotic tissue made and COPECs in soil made with multi-increment soil samples. Tissue samples of insects, birds (eggs), reptiles, and small mammals provide information for contaminant loading in middle trophic levels and, for upper trophic levels, exposure modeling and comparison to literature information on toxic tissue concentrations. Phase III may involve plant tissue samples collocated with soil grab samples for waste site-specific estimates of exposure and lower trophic-level uptake.

Table 9-1. Central Plateau Ecological Data Quality Objective Sampling Design Summary Table Linking Proposed Measures to Risk Questions. (2 Pages)

Phase[a]	Data Type	Risk Question (Chapter 5.0)	Sample Population	Key Features of Design	Basis for Study Design
III	Toxicity testing	RQ1, RQ3	Waste site and reference site soils	Growth and survival tests for plants (using plant species representative of the Central Plateau) and invertebrates (ASTM E2172-01 nematode bioassay).	Provides site-specific information on toxicity of contaminant mixtures and on contaminant bioavailability for Hanford Site soils.
III	Litter bags	RQ2	Waste site and reference site soils	Assess decomposition rates using a standard methodology.	Provides a measure of effect for soil biota.
III	Field surveys	RQ2, RQ4, RQ5, RQ6	Waste sites and reference sites	Proposed measures subject to field verification. Mark and recapture to estimate abundance. Information on resource injuries collected as part of routine animal handling.	Provides another line of evidence to verify modeling estimates or to serve as sole line of evidence for assessment endpoints (reptiles). Provides information of interest to trustees.
I, II, III	Exposure modeling	RQ4, RQ6, RQ7, RQ8	Waste site and reference site soils and biotic tissues	Use of Hanford Site-specific uptake factors for soil to prey (and soil to plants) reduces uncertainty in the use of non-site-specific literature values.	Exposure modeling especially useful in assessing endpoints for which field measures would not be resource effective.
I, II, III	Reconnais-sance and field verification	All risk questions employ information on habitat type, so this applies universally.	Waste sites and reference sites	All sites will be classified according to vegetation and habitat status. Modified Daubenmire plots will be used to assess cover of dominant plants, bare ground, and cryptogams. Reconnaissance also helps to determine where and when to sample.	Field verification necessary to ground the practicality of proposed measures. For example, it may be impractical to collect enough mass of nonviable eggs in the second clutch of ground-nesting birds.
I, II, III	Literature reviews	RQ2, RQ4, RQ5, RQ6	Hanford Site-specific literature on the Central Plateau	Local experts will be familiar with proposed measures and will be consulted for relevant published or in-house information.	Existing Hanford Site-specific data on assessment endpoint abundance to support and aid in the interpretation of proposed field efforts.

[a] The Phase III activities noted in this table will be evaluated in the Phase III data quality objectives activity.

ASTM E2172-01, *Standard Guide for Conducting Laboratory Soil Toxicity Tests with the Nematode* Caenorhabditis elegans.

COPEC = contaminant of potential ecological concern.

An overview of the sampling and analysis options after each investigation phase is described below, and additional details are provided in the Phase I SAP.

Phase I. Characterize exposure and ecological effects of COPECs from Central Plateau Core Zone waste sites (potentially impacted locations) and reference area (assumed unimpacted area, also referred to as "control" site), focusing on waste sites with existing soil COPEC concentration data by collecting Tier 1 soil and biota data.

- Collect surface soil samples to a depth of 15 cm (6 in.) for metals, radionuclides, and organics (PCBs, pesticides). Note: 15 cm (6-in.) depth was selected for Phase I to evaluate the importance of near-surface contamination to biota.
- Collect radiological field data for beta and gamma-emitting radionuclides in soils (e.g., burrow spoils and ant mounds), and plant material to test the conceptual site model of upward contaminant transport (the conceptual model suggests that the 0 to 15 cm [0 to 6-in.] soil interval is important for exposure, but deeper soil also may be important).
- Collect biological data including body analysis for metals, radionuclides, and organics (PCBs, pesticides) in small mammals, lizards, and insects (these animals are common and should have sufficient mass for analysis of all COPECs).
- Note any abnormalities for the vertebrate animals handled, in the field logbooks (these notes will provide qualitative information of the possible effects of COPECs on biota).
- Perform literature review of studies relevant to the Hanford Site, and collect exposure parameter data relevant to the Hanford Site terrestrial receptors and exposure pathways.

Phase II. The Phase II DQO/SAP consider characterization needs for ecological effects of COPECs from the BC Controlled Area, tank farms, West Lake, and the US Ecology Site. The BC Controlled Area is evaluated in Phase II with Tier 1 soil and biota data collection that may include the following.

- Collect surface soil samples to a depth of 15 cm (6 in.) for radionuclides
- Collect radiological field data for beta and gamma-emitting radionuclides in soils (e.g., burrow spoils and ant nests) and plants to test the conceptual site model of downward contaminant transport.
- Collect biological data including body analysis for radionuclides in small mammals, lizards, and insects,
- Note any abnormalities for the animals handled, in the field checklists.

One of the key considerations in the study design is selecting areas for sampling and analysis. This process started with a list of potential sampling domains, based on known processes or releases in the Central Plateau. The sampling domains considered include US Ecology, tank farms, West Lake, and the BC Controlled Area. Of these, the BC Controlled Area is the spatial domain deemed appropriate for sampling in Phase II. For Zones A, B and C, investigation areas will be deployed in each zone. A sagebrush location also will be selected to represent "reference" conditions that are distant from the BC Controlled Area. The reference site may have some impact from airborne deposition if it is on or near the Central Plateau and, therefore, may represent the lowest end of the concentration gradient on the Central Plateau but may not represent a site without any anthropogenic impacts.

Phase III. Phase III begins with a DQA for Phase I and Phase II data, with the overall objective of testing the following aspects of the conceptual model and defining data needs for Phase III.

- Determine if mean concentrations of COPECs detected in surface soil samples are greater than mean background values (DOE/RL-92-24; Ecology 94-115; and DOE/RL-96-12) or mean concentrations at reference sites and also if these COPECs are those expected from process knowledge and previous site sampling.

- Determine if there is uptake of radionuclides in plants or biological transport through ants or burrowing mammals.

- Determine if COPECs are detected in biota samples (invertebrates, lizards, and small mammals) and if these COPECs are those expected from process knowledge and previous site sampling.

- Determine if biota and surface soil data correlate, suggesting that COPECs are present in surface soil and that the surface soil represents the primary exposure medium for ecological receptors.

- Evaluate the results of a literature review of studies relevant to the Hanford Site and the results of the collected exposure parameter data relevant to the Hanford Site to inform subsequent field data collection activities.

In Phase III, the DQOs may be revised based on the DQA findings, leading to the development of a Phase III SAP. The scope would be to characterize the ecological effects of COPECs in Central Plateau habitat (outside of the 200 East and 200 West Areas) by collecting Tier 1 soil and biota data as follows.

- Collect surface soil samples to a depth of 15 cm (6 in.) for metals, radionuclides, and organics (PCBs and pesticides) at selected sites.

- Collect biological data including body analysis for metals, radionuclides, and organics (PCBs and pesticides) in small mammals, birds, lizards, and insects.

- Note abnormalities for the animals handled, in the field logbooks.

Phase III characterization also may include the following Tier 2 data collection activities within the Core Zone, dependent on the findings of the DQA:

- Collection of representative samples of soil below 15 cm (6 in.) to supplement existing waste site data, if needed, to address data gaps identified through the DQA

- Collection of plant tissue and soil grab samples along the rooting depth. This activity is conditional upon measuring COPEC concentrations greater than plant soil-screening values in Phase I and Phase II soil samples
- Collection of data to evaluate population measures for mammals and lizards if the concentrations measured in biota and soil are greater than literature adverse-effect levels
- Conduct of toxicity tests that are conditional on identifying COPECs for soil biota in Phase I and Phase II soil and biota samples
- Evaluation of the need for field verification of ground- and shrub-nesting bird measures
- Determination of whether the density of ground- and shrub-nesting birds is adequate for use in evaluating measures of exposure and effect for middle trophic-level birds
- Implementation of the nestbox (as an alternative) to obtain nest success and egg COPEC concentrations if field verification (Tier 2) shows that the density of ground- and shrub-nesting birds is not at adequate for field studies
- Noting abnormalities for the animals handled, in the field logbooks.

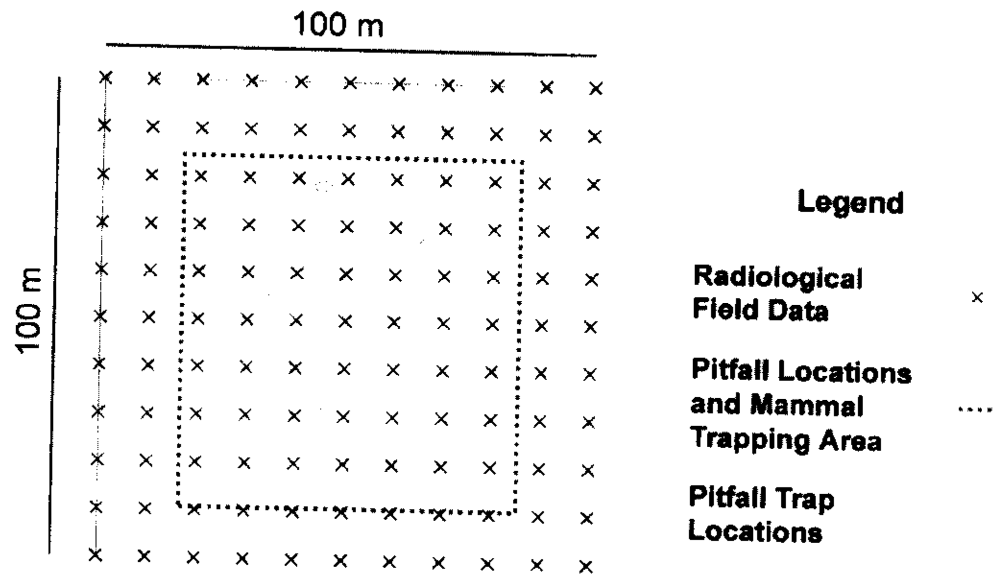
Phase III also includes developing or revising DQOs for the following potential study design elements.

- Develop DQOs for Central Plateau habitat sampling. A focus of Phase III of the Central Plateau EcoDQO is to assess habitat in nonoperational areas to better understand the status and health of the Central Plateau ecosystem.
- Use the DQO process to evaluate the need for adding other reference sites.
- Develop the DQO to assess potential risks to fossorial mammals from the diffuse carbon tetrachloride plume in the 200 West Area. Carbon tetrachloride was identified as a COPEC based on data reviewed in Phase I. No sampling for carbon tetrachloride is planned for Phase I or Phase II, however, because data collection is focused on the 0 to 15 cm (0 to 6 in.) depth interval; measurement of volatile organics in this interval is meaningless because of barometric pumping and solar heating of the soil.
- Revise the existing DQO for West Lake. The West Lake DQO (in the Phase I DQO, WMP-20570, Appendix E) will be revised based on an assessment of available and relevant West Lake studies.

General Aspects of Study Design. A general aspect of the study design is that biological activity decreases with depth, and thus the plan is to characterize no more than the first 1.8 m (6 ft) of soil concentrations as a measure of exposure for biota. Based on the decreasing biological activity with depth, representative surface soil samples will be collected from 0 to 15 cm (0 to 6 in.) and deeper if warranted. Subsurface sampling in Phase III may include representative samples from 15 cm to 1.8 m (0.5 to 6 ft). Using the Phase I data, the hypothesis can be tested that there is a correlation between the near-surface soil concentrations and organism concentrations. This comparison would involve exploratory data analysis of soil concentrations versus organism concentrations.

Representative soil concentrations for wildlife measures will be based on collecting multi-increment samples over a 1 ha plot. Collection and analysis of multi-increment samples is appropriate, because the statistical parameter of interest is the mean concentration (Ecology 92-54, *Statistical Guidance for Ecology Site Managers*, pages 28-29) over hectare-size or larger land areas (see Section 8.1). Because animals are mobile, organisms captured from the investigation area may not have been resident in this area. To minimize the chance of capturing transient animals, biota collection will focus on the central portion of the investigation area. Figure 9-1 is a hypothetical schematic illustrating these sampling concepts. The basis for collecting multi-increment samples is that they are more representative of wildlife exposure to individuals and populations (as discussed in Section 8.1). Existing radiological field data will be supplemented (as necessary) with surveys at grid locations for soil and plants and at locations of biological activity (burrowing mammals or ant nests).

Figure 9-1. Schematic Used to Illustrate Phase II Sampling of BC Controlled Area.



The target quantitation limits for soil and biota are summarized for the study design COPECs in Table 9-2. Target quantitation limits for biotic tissues are derived by calculating the dose to wildlife that is associated with consuming contaminated vertebrates or invertebrates. The dose is based on the radionuclide-specific bioaccumulation factor, and the basis for these target quantitation limits is provided in Table 9-3.

Table 9-2. Synopsis of Target Quantitation Limits for Various Media for Study Design Contaminants of Potential Ecological Concern.

Contaminant of Potential Ecological Concern or Additional Analytes	Chemical Abstracts Service #	Name/Analytical Technology	Units	Target Required Quantitation Limits for Ecological Receptors			Precision Soil and Biota	Accuracy Soil and Biota
				Soil	Vertebrate tissues (fresh wt)	Invertebrate tissues (fresh wt)		
Cesium-137	10045-97-3	GEA	pCi/g	20.8	2290	2290	±30%	70-130%[a]
Strontium-90	Rad-Sr	Total radioactive strontium – GPC	pCi/g	22.5	1710	1710	±30%	70-130%[a]

[a] Accuracy criteria for associated batch laboratory control sample percent recoveries.
GEA = gamma energy analysis. GPC = gas proportional counter.

Table 9-3. Basis for Proposed Radionuclide Target Quantitation Limits in Soil and Biota.

Radionuclide	Terrestrial Animal		
	BCG (pCi/g)	BIV (Concentration in Animal [fresh wt]/ Concentration in Soil)	Concentration in Animal (pCi/g fresh wt) [BCG x BIV]
Cs-137	20.8	110	2290
Sr-90	22.5	75.8	1706

BCG = biota concentration guideline.
BIV = bioaccumulation factor.

9.1 PHASE II STUDY DESIGN FOR RADIOLOGICAL FIELD DATA COLLECTION

Overall considerations: Radiological field data collection for gamma-emitting radionuclides will provide information on the general radioactivity levels across the investigation area and also can help to evaluate biological transport. A 10 m (33-ft) grid will be laid out over the 1 ha investigation area, and soil and plants will be measured at 121 grid points (11 x 11 = 121 points). In addition, locations with biological activity (20 locations with small-mammal burrowing activity and 20 ant mounds) will be measured.

9.2 PHASE II STUDY DESIGN FOR PLANT COVER ESTIMATION

Overall considerations: A modified Daubenmire method (Daubenmire 1959, "A Canopy-Coverage Method of Vegetational Analysis") or line transects is proposed to estimate canopy cover of dominant plant species, bare ground, and cryptogam cover. The Daubenmire method typically consists of systematically placing a 20 by 50 cm (7.9- by 19.7-in.) quadrat frame along a tape on permanently located transects. The following vegetation attributes are typically monitored using the Daubenmire method: canopy cover, frequency, and composition by canopy cover. Canopy cover will be visually estimated. It is important that the same investigators collect these data to minimize differences in observer bias.

Methodology: Each investigation area will be divided into 0.25 ha sections. Within each 0.25 ha subarea, 4 to 10 Daubenmire plots will be placed using a systematic sampling array with a random start. Thus, cover information will be recorded at 16 to 40 plots that encompass the entire investigation area. Photographs will be taken at each plot.

9.3 PHASE II STUDY DESIGN FOR SOIL CONCENTRATIONS

Overall considerations: Reviewing the sum of the fractions identifies Cs-137 and Sr-90 as COPECs. Thus, BCGs (Chapter 3.0) will be used as one line of evidence in the assessment of the ecological effects of radionuclides. Radiological doses or other ecological risk evaluations will be calculated based on receptor spatial boundaries (see Section 8.1), using an integrated data set that will include new data that supplement existing soil data.

Analyses: The analyses include gamma energy analysis (GEA) and total radioactive strontium through a gas proportional counter (GPC). Target quantitation limits are listed in Table 9-3.

Sample type: Sample type includes a multi-increment sample collected over 1 ha.

9.4 PHASE II STUDY DESIGN FOR INVERTEBRATE CONCENTRATIONS

Overall considerations: COPEC concentrations in invertebrates are data that are commonly collected to support ERAs (DOE/RL-2002-35, *Evaluation of Risk to Ecological Receptors from DDT at the Horseshoe Landfill*, and Lane et al. 2003, *Sampling and Analysis Instruction for Soil, Vegetation, and Soil Invertebrate Sampling at Gable Mountain Pond, B-Pond, and a 200 West Reference Location*, provide recent examples of sampling design considerations for the Hanford Site; see also Karr and Kimberling 2003, "A Terrestrial Arthropod Index of Biological Integrity for Shrub-Steppe Landscapes"). One of the considerations in sampling invertebrates is whether to separate the collection into taxonomic groups. However, the density of invertebrates at the Hanford Site is not expected to provide sufficient mass for sample analysis by all taxonomic groups (Lane et al. 2003; Mitchell et al. 2004, *Soil and Biota Collections at Gable Mountain Pond, B-Pond and Control Site*). Invertebrates will be sorted into major groups (e.g., ground beetles and crickets) for chemical/radiological analysis.

Analyses: The analyses include GEA and total radioactive strontium through a GPC. Target quantitation limits are listed in Table 9-3.

Sample type: A composite of invertebrates will be collected in pitfall traps within the 1 ha study plots. Pitfall traps will be located within the inner 7 x 7 m (23 x 23 ft) array to minimize the chance of collecting transient animals and to avoid edge effects.

Sample preparation: Samples will be prepared by homogenizing composites exclusive of external concentrations.

9.5 PHASE II STUDY DESIGN FOR LIZARD CONCENTRATIONS

Overall consideration: The study will collocate lizards with composite soil concentrations within the 1 ha study plots. Lizards will be collected within the inner 7 x 7 m (23 x 23 ft) array to minimize the chance of collecting transient animals and to minimize edge effects. The array will be limited to one habitat type within the BC Controlled Area.

Analyses: The analyses include GEA and total radioactive strontium through a GPC. Target quantitation limits are listed in Table 9-3.

Sample type: Sample type is the individual animal.

Sample preparation: Sample preparation includes homogenizing tissue exclusive of external concentrations.

9.6 PHASE II STUDY DESIGN FOR SMALL MAMMAL CONCENTRATIONS

Overall consideration: Small mammals are collected routinely to evaluate bioaccumulation of COPECs (e.g., Torres and Johnson 2001, "Testing of Metal Bioaccumulation Models with Measured Body Burdens in Mice"). DOE/RL-2002-35 provides a recent example of small-mammal sampling design considerations for the Hanford Site. Animals will be collected within the inner 7 x 7 m (23 x 23 ft) array to minimize the chance of collecting transient animals and to minimize edge effects. The array will be limited to one habitat type within the BC Controlled Area.

Analyses: The analyses include GEA and total radioactive strontium through a GPC. Target quantitation limits are listed in Table 9-3.

Sample type: The sample type is the individual animal.

Sample preparation: Sample preparation includes homogenizing the whole animal exclusive of external concentrations.

9.7 STUDY DESIGN FOR PLANT TOXICITY TEST (TO BE CONSIDERED FOR PHASE III)

Overall considerations: This is a standard toxicity test for soils (Ecology 96-324, *Early Seedling Growth Protocol for Soil Toxicity Screening*). A plant with a readily available and standard seed supply must be selected for the test. For Central Plateau soil, one could select Sandberg's bluegrass (*Poa sanbergii*) for this test. Final selection of a test species will be made in consultation with the toxicity testing laboratory.

Analytical suites: Soil samples submitted for toxicity testing also will be analyzed for standard agricultural parameters (plant nutrients, soil texture, and geochemistry) to help interpret the results of the toxicity test.

Sample type: A large soil sample (roughly 3 L) typically is needed for the test (including five laboratory replicates per sample).

Test endpoints: Test endpoints include emergence count, day 7 post-emergence count, day 7 post-emergence shoot appearance, day 14 post-emergence count, day 14 post-emergence shoot appearance, day 14 post-emergence root appearance, survival, stem height, root length (longest root), shoot mass (wet and dry), root mass (wet and dry), total mass (wet and dry), and total mass (dry) per plant. Differences between test soils, laboratory controls, and reference materials will be evaluated using Dunnett's multiple comparison t-test or the Kruskal-Wallis nonparametric test (depending on whether the data appear to be derived from a normal distribution).

9.8 STUDY DESIGN FOR NEMATODE TEST (TO BE CONSIDERED FOR PHASE III)

Overall considerations: ASTM E2172-01, *Standard Guide for Conducting Laboratory Soil Toxicity Tests with the Nematode Caenorhabditis elegans*, is a standard toxicity test for soils. The test currently is established for only a single species - *Caenorhabditis elegans*.

Analytical suites: Soil samples submitted for toxicity testing also will be analyzed for geochemical parameters (e.g., pH, others suggested in ASTM E2172-01) to help interpret the results of the toxicity tests.

Sample type: Individual field soil samples are needed for each test replicate (a minimum of three [plus laboratory replicates] are required and five replicates are proposed). The soil samples should be checked for the presence/absence of organic material, and the samples must be sieved. Soil samples must be hydrated to a standard level and allowed to equilibrate for 7 days.

Test endpoints: This test measures mortality only, and the test duration is either 24 or 48 hours. This test will be run for 24 hours so that food does not need to be supplied. Differences between test soils, laboratory controls, and reference materials will be evaluated using Dunnett's multiple comparison t-test or the Kruskal-Wallis nonparametric test (depending on whether the data appear to be derived from a normal distribution).

9.9 STUDY DESIGN FOR LITTERBAG DECOMPOSITION TEST (TO BE CONSIDERED FOR PHASE III)

Overall consideration: Toxicant effects on decomposition can be measured in several ways; one of the simplest techniques is the litterbag test, a standard assay for soils (Heath et al. 1964, "Some Methods for Assessing the Activity of Soil Animals in the Breakdown of Leaves," and Markwiese et al. 2001, "Toxicity Bioassays for Ecological Risk Assessment in Arid and Semiarid Ecosystems"). Soil properties and microbial activity (one of the key components of the decomposer community) have been shown to vary across an elevational gradient at the Hanford Site (Smith et al. 2002, "Soil Properties and Microbial Activity Across A 500 m Elevation Gradient in A Semi-Arid Environment"). Thus, supporting data on soil properties are recommended to interpret the results of the litterbag tests.

Analytical suites: Soil samples submitted for toxicity testing also will be analyzed for geochemical parameters (e.g., pH) to help interpret the results of the decomposition test.

Methodology: The basic techniques are to enclose preweighed plant litter in a mesh bag, bury it, and after a period of time collect and weigh the bag's contents, comparing the mass loss relative to similarly bagged litter in reference soils (Markwiese et al. 2001). Litterbags of 40 μm mesh size (to exclude invertebrates) are used to assess decomposition from microorganisms only. Preweighed cellulose disks (two disks at 20 x 20 cm [7.9 x 7.9 in.]) will be placed in a bag and at each sampling point; two bags will be placed and covered with several centimeters of soil.

Degradation of the cellulose paper disks will be assessed visually by estimating the percentage disk area remaining after decomposition and by measuring the dry weight of each of the four disks.

Test endpoints: This test measures mass, reduced over time. Differences between test and reference soils will be evaluated using Dunnett's multiple comparison t-test or the Kruskal-Wallis nonparametric test (depending on whether the data appear to be derived from a normal distribution).

9.10 STUDY DESIGN FOR PLANT CONCENTRATIONS (TO BE CONSIDERED FOR PHASE III)

Overall considerations: COPEC concentrations in plants are data that are commonly collected to support ERAs (DOE/RL-2002-35 and Lane et al. 2003 provide recent examples of sampling design considerations for the Hanford Site). One of the considerations in sampling plant tissue is whether to collect and analyze separate samples of root, foliage, and reproductive tissues. One Hanford Site study showed that roots and foliage have similar concentrations of radionuclides (Landeen and Mitchell 1986, "Radionuclide Uptake By Trees at A Radwaste Pond in Washington State"). Because some receptors forage on reproductive tissues and others forage on foliage, samples of foliage and reproductive tissues will be collected and analyzed separately. Potential differences between concentrations in the foliage versus the roots will be considered in the uncertainty analysis for this risk assessment.

Analytical suites: Analytical suites will be determined by the DQA of the Phase I/II data

Sample type: Composite vegetative and reproductive parts are sampled separately.

Sample preparation: Samples will be prepared by homogenizing tissue exclusive of external concentrations.

9.11 STUDY DESIGN FOR SHRUB-STEPPE BIRD (GROUND OR SHRUB NESTING SPECIES) POPULATION SURVEYS (TO BE CONSIDERED FOR PHASE III)

Overall consideration: This data element is subject to field verification to determine if sufficient numbers of nests and eggs can be obtained. Field verification is needed to determine that adequate numbers of nests can be located on the study area (1 ha) and, based on the reported low density of representative birds (less than 1 to 3 birds/ha, see Table 8-1), this may be problematic. Large study areas (36 to 18,000 ha) are common in literature studies of grassland or shrub-steppe birds (Fair et al. 1995, "Effects of Carbaryl Grasshopper Control on Nesting Killdeer in North Dakota"; Martin et al. 2000, "Effects of Two Grasshopper Control Insecticides on Food Resources and Reproductive Success of Two Species of Grassland Songbirds"; Pidgeon et al. 2003, "Landscape-Scale Patterns of Black-Throated Sparrow (*Amphispiza Bilineata*) Abundance and Nest Success"). Thus, an alternative to surveys of shrub-steppe species may have to be considered. One option is to use a nonmigratory species (e.g., starlings).

Survey locations and data collection: The nests of species that primarily forage on invertebrates (e.g., sage sparrow, meadowlark, killdeer) will be marked and revisited to determine the breeding success and the gender ratio of nestlings. Although some investigators have discounted investigator effects on nesting success of arid-zone birds (Lloyd et al. 2000, "Investigator Effects on the Nesting Success of Arid-Zone Birds"), others have suggested that frequent visitation will impact bird counts (Brandt and Rickard 1992, "Effects of Survey Frequency on Bird Density Estimates in the Shrub-Steppe Environment"). Thus, to lessen any impacts, frequency of visits will be based on intervals that minimize disturbance to the adults and nestlings and the proper intervals to determine nest success parameters (roughly 4-7 days). Infertile eggs will be collected from the second clutch (minimum of six per species per study area) for contaminant analysis. Information on eggshell thickness and volume will be recorded.

9.12 STUDY DESIGN FOR EGG CONCENTRATIONS (TO BE CONSIDERED FOR PHASE III)

Overall considerations: COPEC concentrations in eggs are data that are collected to support ERAs (DOE/RL-2002-35 provides a recent example of sampling design considerations for the Hanford Site). Nonviable eggs are selected as a nonintrusive method to assess bioaccumulation and exposure, and the second clutch of migratory species is indicative of local exposures (as opposed to exposures obtained elsewhere during migration). If the second clutch cannot be obtained, then it will be difficult to partition the COPECs measured in eggs to Hanford Site exposures and exposures obtained during migration (see Minh et al. 2002, "Persistent Organochlorine Residues and Their Bioaccumulation Profiles in Resident and Migratory Birds from North Vietnam," for an example of the comparison of migratory and nonmigratory species). Other material such as feathers can be analyzed for contaminants, but similar problems occur for migratory species, because concentrations in feathers reflect blood concentrations at the time of feather formation (Burger and Gochfeld 1995, "Biomonitoring of Heavy Metals in the Pacific Basin Using Avian Feathers") and thus may not reflect Hanford Site exposures. For these reasons, many studies use nonmigratory species (e.g., Gragnaniello et al. 2001, "Sparrows as Possible Heavy-Metal Biomonitors of Polluted Environments"; Chao et al. 2003, "Metal Contamination in Tree Sparrows in Different Locations of Beijing").

Analytical suites: Analytical suites will be determined by the DQA of the Phase I/II data.

Sample type: Sample type will be egg contents without the shell, except if Sr-90 results are needed; then the eggshell will be analyzed.

Sample preparation: Sample preparation will include homogenizing egg contents or eggshell.

9.13 STUDY DESIGN FOR LIZARD POPULATION SURVEYS (TO BE CONSIDERED FOR PHASE III)

Overall considerations: Lizard population surveys routinely are used in ecological studies. But these data are not routinely collected for ERAs, and field verification of the proposed measures for Hanford Site conditions is important. Based on the reported density of side-blotched lizards from the literature (see Table 8-1), field measures of abundance should be feasible within the 1 ha study plots.

Survey locations and data collection: Marking and re-observation will be performed to determine abundance. Weight and snout-vent length will be determined for animals as they are collected. Information on deformities will be recorded, and samples (tails or adult) will be collected after the animal is documented to have been resident on the study plot.

9.14 STUDY DESIGN FOR SMALL MAMMAL TRAPPING (TO BE CONSIDERED FOR PHASE III)

Overall considerations: Small mammal population studies are commonly used to support ERAs. Capturing individuals in all reproductive classes (juvenile males, nonscrotal males, scrotal males, juvenile females, adult females, pregnant females, lactating females) provides an indication that the population is recruiting new individuals at the site. This information also can be used to evaluate gender ratios, and mark-recapture provides information on animal abundance.

Survey locations and data collection: Small mammals will be trapped within the inner 70 x 70 m (230 x 230 ft) portion of the study plot to avoid edge effects. The inner 7 x 7 m (23 x 23 ft) array (at 10 m [33-ft] spacing) will be trapped to minimize the chance of collecting transient animals and to minimize edge effects. Trapping arrays will be limited to one habitat type (if at all possible). Trapping will be conducted over 4-5 nights, and the separate trapping events will occur in a 2-4 week interval to document animals resident on the trapping array. Animals captured will be marked with ear tags or equivalent (the pocket mouse has small ears, so alternate marking is needed). Information will be recorded on deformities, and animals will be collected (minimum of 6 per species per set of arrays) for contaminant analysis.

9.15 FIELD RECONNAISSANCE/VERIFICATION

Overall considerations: Field reconnaissance/verification will support all field measures proposed in the study design and will provide a basis for documenting inclusion/exclusion of waste sites selected as ecological study plots and appropriate reference sites.

9.16 LITERATURE REVIEWS

Overall considerations: Literature reviews of relevant ecological data published in the peer reviewed or other literature is useful for putting the results from these proposed studies into context. Literature that provides overall trends for biota in the shrub steppe (e.g., Knick et al. 2003, "Teetering on the Edge or Too Late? Conservation and Research Issues for Avifauna of Sagebrush Habitats"), as well as published studies regarding field measurements of adverse effects for Central Plateau COPECs (e.g., Custer et al. 2003, "Exposure and Effects of Chemical Contaminants on Tree Swallows Nesting Along the Housatonic River, Berkshire County, Massachusetts, USA, 1998-2000") also are useful. However, the studies that provide the most utility and context are those that deal with waste sites (e.g., DOE/RL-2002-35; Mitchell et al. 2004) or annual environmental surveillance reports and other special studies (e.g., Kimberling et al. 2001, "Measuring Human Disturbance Using Terrestrial Invertebrates in the Shrub-Steppe Of Eastern Washington (USA)"; Kimberling and Karr 2002, *A New Approach to Assessing Ecological Health: Developing an Index of Biological Integrity with Insects at Hanford*).

9.17 EXPOSURE MODELING

Overall considerations: Exposure models will be based on site-specific exposure parameters and literature toxicity data. If site-specific exposure data are not available, then data collected in a shrub-steppe environment will be used. Other exposure data also will be considered as appropriate. Toxicity data will be based on Cs-137 and Sr-90. Spatial averages will be based on an appropriate spatial scale for individuals and populations (see Section 8.1).

Data will be evaluated for statistically increased tissue concentrations versus soil concentrations (i.e., transfer factors or more complex bioaccumulation models). Contaminant transfer or bioaccumulation factors are an empirical ratio of contaminants in soil to contaminants in biota, which are used in exposure modeling. Adverse effects are inferred by the ratio of exposure to effects levels (TRVs). It is assumed that the dose received orally for terrestrial wildlife can be described mathematically as one of the two following equations:

$$E_{oral} = [C_{soil} \cdot I_{food} \cdot fs + C_{food}] \cdot AUF$$

where

E_{oral} is the estimated oral daily dose for a COPEC (mg-COPEC/kg-body weight/day)

C_{soil} is the concentration of chemical constituent x in soil (mg/kg dry weight)

I_{food} is the normalized daily dietary ingestion rate (kg-dry weight/kg-body weight/day)

fs is the fraction of soil ingested, expressed as a fraction of the dietary intake

C_{food} is the concentration of COPEC in food (mg/kg-dry weight)

AUF is the area use factor for the receptor (ratio of the investigation area to the home range, but no larger than 1.0);

or

$$E_{oral} = C_{soil} \cdot I_{food} \cdot [fs + TF_{food}] \cdot AUF$$

where

E_{oral} is the estimated oral daily dose for a COPEC (mg-COPEC/kg-body weight/day)

C_{soil} is the concentration of chemical constituent x in soil (mg/kg dry weight)

I_{food} is the normalized daily dietary ingestion rate (kg-dry weight/kg-body weight/day)

fs is the fraction of soil ingested, expressed as a fraction of the dietary intake

TF_{food} is a transfer factor from soil to food (mg/kg food dry weight per mg/kg soil dry weight)

AUF is the area use factor for the receptor (ratio of the investigation area to the home range, but no larger than 1.0).

The above equations assume that a single food type is ingestion and that exposure modeling must be specific for herbivores, omnivores, insectivores, and carnivores. This model is the same as that used in the WAC 173-340-900, Table 749-4, for evaluation of the ecological effects of contaminants on terrestrial wildlife (WAC 173-340-7492, "Simplified Terrestrial Ecological Evaluation Procedures"). Exposure modeling will be based on site-specific soil COPEC data and on COPECs detected in the three taxonomic representatives of middle trophic-level species (invertebrates, lizards, and small mammals) sampled for tissue analyses. Home ranges for Central Plateau receptors are provided in this document (Table 8-1). Avian and mammalian TRVs for the COPECs being evaluated also are provided in this document. Soil ingestion values will be obtained from the literature for the receptors considered in the Central Plateau or from appropriate surrogate receptors (Beyer et al. 1994, "Estimates of Soil Ingestion by Wildlife"). A framework for considering uncertainties in exposure-related (e.g., ingestion rate) and toxicity-related parameters is described in LA-UR-04-8246, *Screening-Level Ecological Risk*

Assessment Method, Rev. 2, and will be adopted for evaluating uncertainty in this Central Plateau EcoDQO.

Tables 9-2 and 9-3 present target quantitation limits in soil for ecological receptors. For purposes of comparison, values related to the preliminary human health cleanup levels for Hanford Site soils are included in Table 9-4.

Table 9-4. Preliminary Human Health-Related Soil Cleanup Levels.

Contaminant of Potential Ecological Concern or Additional Analytes	Chemical Abstracts Service Number	Units	Direct Exposure, Rural-Residential	Direct Exposure, Industrial
Cesium-137	10045-97-3	pCi/g	6.2	23.4
Strontium-90	Rad-Sr	pCi/g	4.5	2,530

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10.0 SCIENTIFIC MANAGEMENT DECISION POINT FOR STUDY DESIGN / DATA QUALITY OBJECTIVES

In this document the study design step of an ERA has been described. Study design represents a synopsis of the information (measures) considered to evaluate whether there are effects of COPECs on the AEs defined in problem formulation. Ultimately these information needs are satisfied through the Phase II SAP (DOE/RL-2005-30) that has been developed based on this study design. Concerns over the study design and DQOs (Chapters 7.0 through 9.0) have been addressed through public workshops, the aforementioned Phase II SAP, and Phase I DQO and SAP documentation.

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11.0 REFERENCES

ARH-CD-775, 1975, *Geohydrologic Study of the West Lake Basin*, Atlantic Richfield Hanford Company, Richland, Washington.

ASTM E2172-01, 2003, *Standard Guide for Conducting Laboratory Soil Toxicity Tests with the Nematode* Caenorhabditis elegans, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

Beyer, W. N., E. E. Connor, and S. Gerould, 1994, "Estimates of Soil Ingestion by Wildlife," *Journal of Wildlife Management* 58:375-382.

BHI-01319, 1999, *Data Assessment Report for the Sampling and Analysis Activities Conducted to Support Reposting the 200 B/C Contaminated Area*, Decisional Draft, Bechtel Hanford, Inc., Richland, Washington.

Bowman, J. A., G. Jaeger, and L. Fahrig, 2002, "Dispersal Distance of Mammals is Proportional to Home Range Size," *Ecology* 83:2049-55.

Brandt, C. A., and W. H. Rickard, Jr., 1992, "Effects of Survey Frequency on Bird Density Estimates in the Shrub-Steppe Environment," *Northwest Science* 66:172-182.

Burger, J., and M. Gochfeld, 1995, "Biomonitoring of Heavy Metals in the Pacific Basin Using Avian Feathers," *Environmental Toxicology and Chemistry* 14:1233-1239.

Canadell, J., R. B. Jackson, J. R. Ehleringer, H. A. Mooney, O. E. Sala, and E. D. Schulze, 1996, "Maximum Rooting Depth of Vegetation Types at the Global Scale," *Oecologia* 108:583-595.

Carlsen, T. M., J. D. Coty, and J. R. Kercher, 2004, "The Spatial Extent of Contaminants and the Landscape Scale: An Analysis of the Wildlife, Conservation Biology, and Population Modeling Literature," *Environmental Toxicology and Chemistry* 23:798-811. [Appendices available on-line as document UCRL-JC-155043 at http://www-erd.llnl.gov/library/]

Chao, P., Z. Guangmei, Z. Zhengwang, and Z. Chengyi, 2003, "Metal Contamination in Tree Sparrows in Different Locations of Beijing," *Bulletin of Environmental Contamination and Toxicology* 71:142-147.

Chapman, J. A., and G. A. Feldhamer (eds), 1982, *Wild Mammals of North America: Biology, Management, Economics*, The Johns Hopkins University Press, Baltimore, Maryland, 1147 pp.

Cline, J. F., 1981, "Aging Effects on the Availability of Strontium and Cesium to Plants," *Health Physics* 41:293-296.

Cline, J. F. and W. H. Rickard, 1972, "Radioactive Strontium and Cesium in Cultivated and Abandoned Field Plots," *Health Physics* 23:317-324.

Cline, J. F. and L. L. Cadwell, 1984, "Movement of Radiostrontium in the Soil Profile in an Arid Climate," *Health Physics* 46: 1136-1138.

Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC 9601, et seq.

Custer, C. M., T. W. Custer, P. M. Dummer, P. M. Dummer, and K. L. Munney, 2003, "Exposure and Effects of Chemical Contaminants on Tree Swallows Nesting Along the Housatonic River, Berkshire County, Massachusetts, USA, 1998-2000," *Environmental Toxicology and Chemistry* 22:1605-1621.

D&D-24693, 2005, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

Daubenmire, R., 1959, "A Canopy-Coverage Method of Vegetational Analysis," *Northwest Science*, 33:43-64.

DOE/EH-0676, 2004, *RESRAD-BIOTA: A Tool for Implementing A Graded Approach to Biota Dose Evaluation*, Users Guide, Version 1, Interagency Steering Committee on Radiation Standards, ISCORS Technical Report 2004-02, U.S. Department of Energy, Environment, Safety and Health, Washington, D.C.

DOE/RL-92-24, 1995, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U. S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-12, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-38, 2001, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-54, 2003, *Central Plateau Ecological Evaluation*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-35, 2002, *Evaluation of Risk to Ecological Receptors from DDT at the Horseshoe Landfill*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-42, 2003, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units, (Includes the 200-PW-5 Operable Unit)*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-42, 2005, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2005-30, 2005, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase II*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2005-37, 2005, *Status of Hanford Site Risk Assessment Integration, FY 2005*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-STD-1153-2002, 2002, *A Graded Approach For Evaluating Radiation Doses To Aquatic And Terrestrial Biota*, DOE Technical Standard, U.S. Department of Energy, Richland Operations Office, Washington, DC.

Ecology 92-54, 1992, *Statistical Guidance for Ecology Site Managers*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

Ecology 94-115, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

Ecology 96-324, 1996, *Early Seedling Growth Protocol for Soil Toxicity Screening*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

EGG-1183-1661, 1975, *An Aerial Radiological Survey of the U.S. Energy Research and Development Administration's Hanford Reservation (Survey Period: 1973-1974)*, EG&G Energy Measurements, Inc., Las Vegas, Nevada.

EPA, 1999, *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (Memorandum), OSWER Directive 9285.7-28P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2003a, *Guidance for Developing Ecological Soil Screening Levels*, OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at: http://www.epa.gov/ecotox/ecossl/pdf/ecossl_guidance_chapters.pdf

EPA, 2003b, *Guidance for Developing Ecological Soil Screening Levels*, Attachment 1-3, *Evaluation of Dermal Contact and Inhalation Exposure Pathways for the Purposes of Setting Eco-SSLs*, OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at: http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_1-3.pdf

EPA/540/R-97/006, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at: http://www.epa.gov/superfund/programs/risk/ecorisk/ecorisk.htm

EPA/600/R-93/187a, 1993, *Wildlife Exposure Factors Handbook*, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=2799

EPA/630/R-95/002F, 1998, *Guidelines for Ecological Risk Assessment*, U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, D.C. Available on the Internet at: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=12460

Fair, J. M., P. L. Kennedy, and L. C. McEwen, 1995, "Effects of Carbaryl Grasshopper Control on Nesting Killdeer in North Dakota," *Environmental Toxicology and Chemistry* 14:881-890.

Fairbrother, A., 2003, "Lines of Evidence in Wildlife Risk Assessments," *Human and Ecological Risk Assessment* 9:1475-1491.

Gano, K. A., 1981, "Mortality of the Harvester Ant (*Pogonomyrmex owyheei*) after Exposure to ^{137}Cs Gamma Radiation," *Environmental Entomology* 10:39-44.

Gragnaniello, S., D. Fulgione, M. Milone, O. Soppelsa, P. Cacace, and L. Ferrara, 2001, "Sparrows as Possible Heavy-Metal Biomonitors of Polluted Environments," *Bulletin of Environmental Contamination and Toxicology* 66:719-726.

Heath, G. W., C. A. Edwards, and M. K. Arnold, 1964, "Some Methods for Assessing the Activity of Soil Animals in the Breakdown of Leaves," *Pedobiologia* 4:80-87.

Jones, D. S., S. Domoter, K. Higley, D. Kocher, and G. Bilyard, 2003, "Principles and Issues in Radiological Ecological Risk Assessment," *Journal of Environmental Radioactivity* 66:19-39.

Karr, J. R., and D. N. Kimberling, 2003, "A Terrestrial Arthropod Index of Biological Integrity for Shrub-Steppe Landscapes," *Northwest Science* 77:202-213.

Kennedy, W. F., L. L. Cadwell, and D. H. McKenzie, 1985, "Biotic Transport of Radionuclide Wastes from A Low-Level Radioactive Waste Site," *Health Physics* 49: 11–24.

Kimberling, D. N., and J. R. Karr, 2002, *A New Approach to Assessing Ecological Health: Developing an Index of Biological Integrity with Insects at Hanford*, Web publication through the Consortium for Risk Evaluation with Stakeholder Participation, University of Washington, Seattle, Washington. Available on the Internet at: http://www.cresp.org/dcwrkshp/posters/ibi/ibi.html (19 pp.)

Kimberling, D. N., J. R. Karr, and L. S. Fore, 2001, "Measuring Human Disturbance Using Terrestrial Invertebrates in the Shrub-Steppe Of Eastern Washington (USA)," *Ecological Indicators* 1:63-81.

Knick, S. T., D. S. Dobkin, J. T. Rontenberry, M. A. Schroeder, W. M. Vander Haegen, and C. van Ripper, III, 2003, "Teetering on the Edge or Too Late? Conservation and Research Issues for Avifauna of Sagebrush Habitats," *The Condor* 105:611-634.

Landeen D., and J. Crow, 1997, *A Nez Perce Nature Guide: I am of this Land* Wetes pe m'e wes, Western Printing, Clarkston, Washington.

Landeen, D. S., and R. M. Mitchell, 1986, "Radionuclide Uptake By Trees at A Radwaste Pond in Washington State," *Health Physics* 50:769-774

Lane, N. K., J. K. Linville, R. M. Mitchell, and R. S. Zack, 2003, *Sampling and Analysis Instruction for Soil, Vegetation, and Soil Invertebrate Sampling at Gable Mountain Pond, B-Pond, and a 200 West Reference Location*, Draft, Lane Environmental, Inc., North Bend, Washington, October 22.

LA-UR-04-8246, 2004, *Screening-Level Ecological Risk Assessment Methods*, Rev. 2, Los Alamos National Laboratory, Los Alamos, New Mexico.

Lloyd, P., R. M. Little, and T. M. Crowe, 2000, "Investigator Effects on the Nesting Success of Arid-Zone Birds," *Journal of Field Ornithology* 71:227-235.

Markwiese, J. T., R. T. Ryti, M. M. Hooten, D. I. Michael, and I. Hlohowskyj, 2001, "Toxicity Bioassays for Ecological Risk Assessment in Arid and Semiarid Ecosystems," *Reviews of Environmental Contamination and Toxicology* 168:43-98.

Martin, P. A., D. L. Johnson, D. J. Forsyth, and B. D. Hill, 2000, "Effects of Two Grasshopper Control Insecticides on Food Resources and Reproductive Success of Two Species of Grassland Songbirds," *Environmental Toxicology and Chemistry* 19:2987-2996.

Meadows, P. S., and A. Meadows (eds), 1991, *The Environmental Impact of Burrowing Animals and Animal Burrows*, Clarendon Press, Oxford, England.

Minh, T. B., T. Kunisue, N. T. H. Yen, M. Watanabe, S. Tanabe, N. D. Hue, and V. Qui, 2002, "Persistent Organochlorine Residues and Their Bioaccumulation Profiles in Resident and Migratory Birds from North Vietnam," *Environmental Toxicology and Chemistry* 21:2108-2118.

Mitchell, R. M., N. K. Lane, and R. S. Zack, 2004, *Soil and Biota Collections at Gable Mountain Pond, B-Pond and Control Site*, Duratek Technical Services, Richland, Washington.

O'Connor, G, and K. Wieda, 2001, *Northwest Arid Lands: An Introduction to the Columbia Basin Shrub-Steppe*, Battelle Press, Columbus, Ohio.

O'Farrell, T. P., 1975, "Seasonal and Altitudinal Variations in Populations of Small Mammals on Rattlesnake Mountain, Washington," *American Midland Naturalist* 94:190-204.

O'Farrell, T. P., R. J. Olsen, R. O. Gilbert, and J. D. Hedlund, 1975, "A Population of Great Basin Pocket Mice (*Perognathus Parvus*) in the Shrub-Steppe of South-Central Washington," *Ecological Monographs* 45:1-28.

Pidgeon, A. M., V. C. Radeloff, and N. E. Mathews, 2003, "Landscape-Scale Patterns of Black-Throated Sparrow (*Amphispiza Bilineata*) Abundance and Nest Success," *Ecological Applications* 13:530-542.

PNL-2499, 1998, *Comparative Ecology of Nuclear Waste Ponds and Streams on the Hanford Site*, Pacific Northwest Laboratory, Richland, Washington.

PNL-2774, 1979, *Characterization of the Hanford 300 Area Burial Grounds: Task IV – Biological Transport*, Pacific Northwest Laboratory, Richland, Washington.

PNL-4140, 1984, *Habitat Requirements and Burrowing Depths of Rodents in Relation to Shallow Waste Burial Sites*, Pacific Northwest Laboratory, Richland, Washington.

PNL-5247, 1985, *Rooting Depth and Distribution of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site*, Pacific Northwest Laboratory, Richland, Washington.

PNL-7662, 1991, *An Evaluation of the Chemical Radiological and Ecological Conditions of West Lake on the Hanford Site*, Pacific Northwest Laboratory, Richland, Washington.

PNL-9394, 1994, *Ecotoxicity Literature Review of Selected Hanford Site Contaminants*, Pacific Northwest Laboratory, Richland, Washington.

PNNL-6415, 2003, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 15, Pacific Northwest National Laboratory, Richland, Washington. Available on the Internet at: http://www.pnl.gov/ecology/Library/NEPA.html

PNNL-14187-SUM, 2003, *Summary of Hanford Site Groundwater Monitoring for Fiscal Year 2002*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-SA-32196, 2000, *Hanford Site Ecological Monitoring & Compliance*, "Hanford Site Species Listings," last updated December 11, 2000, Pacific Northwest National Laboratory, Richland, Washington. Available on the Internet at: http://www.pnl.gov/ecomon/Species/Mammal.html

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

Reynolds, T. D., and J. W. Laundré, 1988, "Vertical Distribution of Soil Removed by Four Species of Burrowing Rodents in Disturbed and Undisturbed Soils," *Health Physics* 54:445–450.

RHO-SA-211, 1981, *Intrusion of Radioactive Waste Burial Sites by the Great Basin Pocket Mouse (*Perognathus Parvus*)*, Rockwell Hanford Operations, Richland, Washington.

Rogers, L. E., and R. E. Fitzner, 1980, "Characterization of Darkling Beetles Inhabiting Radioecology Study Areas at the Hanford Site in Southcentral Washington," *Northwest Science* 54:202-206.

Rogers, L. E., N. E. Woodley, J. K. Sheldon, and P. A. Beedlow, 1988, "Diets of Darkling Beetles (Coleoptera: Tenebrionidae) Within A Shrub-Steppe Ecosystem," *Annals of the Entomological Society of America* 81:782-791.

Rundel, P. W., and A. C. Gibson, 1996, *Ecological Communities and Processes in a Mojave Desert Ecosystem: Rock Valley, Nevada*, Cambridge University Press, New York, New York, 369 pp.

Ryti, R. T., J. Markwiese, R. Mirenda, and L. Soholt, 2004, "Preliminary Remediation Goals for Terrestrial Wildlife," *Human and Ecological Risk Assessment* 10:1-14.

Smith, J. L., J. J. Halvorson, and H. Bolton, Jr., 2002, "Soil Properties and Microbial Activity Across A 500 m Elevation Gradient in A Semi-Arid Environment," *Soil Biology & Biochemistry* 34:1749-1757.

Sutherland, G. D., A. S. Harestad, and K. Price, 2000, "Scaling of Natal Dispersal Distances in Terrestrial Birds and Mammals," *Conservation Ecology* 4(1):16. Available on the Internet at http://www.consecol.org/vol4/iss1/art16/index.html

TNC, 1999, *Biodiversity Inventory and Analysis of the Hanford Site, Final Report 1994-1999*, The Nature Conservancy of Washington, Seattle, Washington.

Torres, K. C., and M. L. Johnson, 2001, "Testing of Metal Bioaccumulation Models with Measured Body Burdens in Mice," *Environmental Toxicology and Chemistry* 20:2627-2638.

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-747, "Deriving Soil Concentrations for Ground Water Protection," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC-173-340-900, "Tables," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7490, "Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7490(3)(b), "Terrestrial Ecological Evaluation Procedures," "Goal," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7490(4)(a), "Terrestrial Ecological Evaluation Procedures," "Point of Compliance, "Conditional Point of Compliance," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7490(4)(b), "Terrestrial Ecological Evaluation Procedures," "Point of Compliance, "Standard Point of Compliance," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7492, "Simplified Terrestrial Ecological Evaluation Procedures," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7493(2), "Site-Specific Terrestrial Ecological Evaluation Procedures," "Problem Formulation Step," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7493(7)(c), "Site-Specific Terrestrial Ecological Evaluation Procedures," "Substitute Receptor Species," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

Washington Administrative Code, as amended, Washington State Department of Ecology, Olympia, Washington.

WDFW, 2003, *Washington Department of Fish and Wildlife's Priority Habitat and Species Management Recommendations, Vol IV: Birds – Sage Sparrow*, Amphispiza belli, Washington Department of Fish and Wildlife, Olympia, Washington. Available on the Internet at: http://wdfw.wa.gov/hab/phs/vol4/sage_sparrow.pdf

WHC-EP-0771, 1994, *Comparison of Radionuclide Levels in Soil, Sagebrush, Plant Litter, Cryptogams, and Small Mammals*, Westinghouse Hanford Company, Richland, Washington.

Whicker, F. W., T. G. Hinton, M. M. MacDonell, J. E. Pinder III, and L. J. Habegger, 2004, "Avoiding Destructive Remediation at DOE Sites," *Science* 303:1615-1616, March 12.

WMP-18647, 2004, *Historical Site Assessment of the Surface Radioactive Contamination of the BC Controlled Area*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WMP-20570, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, Fluor Hanford, Inc., Richland, Washington.

APPENDIX A

PARTICIPANT ISSUES AND RESOLUTION

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CONTENTS

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APPENDIX A

PARTICIPANT ISSUES AND RESOLUTION

1.0 TABLE

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
PROJECT SCOPE			
1	The schedule revisions that deferred the fiscal year 2004 sampling raise a concern over the Phase III scope, specifically the habitat sampling outside of the Core Zone. Will that scope be retained or will it be subject to change for cost or other reasons? (DS)	Y	The Phase III habitat sampling outside the Core Zone remains a vital part of this phased ecological risk assessment.
2	The Office of River Protection properties do not represent good habitat for ecological sampling for several reasons: 1. The native soils have been covered with gravel and sprayed extensively with herbicides and pesticides to prevent habitat growth and animal intrusion. 2. Animal intrusion is partly inhibited by barrier fences and also by deliberate trapping and disposal of intruders. Washington State Department of Ecology has been pressing ORP to perform near-term remediation of the surface and subsurface soils that would drastically alter the current site conditions. The significant effort and expense associated with ecological sampling in the tank farm properties would be lost as a result of the remediation activities. (FA, TK)	Y	Agree
3	How will DOE integrate multiple ongoing or planned risk assessments for the Hanford Site; e.g., how will groundwater and terrestrial risk assessments be integrated? The groundwater risk analysis must be made in time for source remediation. Also, DOE needs to address how the 200 Areas Central Plateau risk assessment fits into the overall risk assessment for the Hanford Site.	Y	This topic is outside of the direct scope of the Central Plateau ecological DQO. DOE recently issued DOE/RL-2005-37 in response to Trustee concerns. This document is the most comprehensive source of risk assessment information available.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
ERAGS STEP 3: PROBLEM FORMULATION			
REFINEMENT OF PRELIMINARY CONTAMINANTS OF CONCERN			
4	The COPEC screening must be properly based on process history and not on a generic contaminant list, to ensure the comprehensiveness of the COPEC assessment. (DS)	Y	The COPEC screening process for the Phase II EcoDQO is different than that used in Phase I, because specific data are available for the Phase II areas. The draft BC Controlled Area radionuclide COPEC list is based on maximum concentrations of surface soil data from BHI-01319. The sum of fractions for these data is 262 (or dose equal to 26 rad/day), of which Sr-90 represents 58 percent and Cs-137 is 42 percent of the sum of fractions; other radionuclides contributed less than 0.001 percent of the sum of fractions. Consequently, Cs-137 and Sr-90 are the radioactive COPECs. The nonradionuclide COPECs are based on a characterization activity that analyzed BC Controlled Area soils for metals, total uranium, anions, and total polychlorinated biphenyls (D&D-24693). Sampling was performed in the most highly contaminated and the moderately contaminated portions of the BC Controlled Area.
5	Clarification is requested on whether radiological surveys will be the basis for focused sampling in the BC Controlled Area. (CC, DF, LG)	Y	Radiological surveys were used to provide for more directed sampling of the areas likely having the highest levels of contamination in the BC Controlled Area.
CONTAMINANT FATE AND TRANSPORT, ECOSYSTEMS POTENTIALLY AT RISK, AND COMPLETE EXPOSURE PATHWAYS			
6	May not be good alternatives to mice and birds in middle trophic level, but badger tissue may be helpful if possible to sample without mortality. Would like to see general area biological sampling for birds and mice using areal decision units to minimize potential to skew results. US Fish and Wildlife developed a similar approach in a Technical Assistance Proposal for the Hanford North Slope. It was based on sampling over a 1 square mile grid and included a cost estimate. (JP)	Y	Badgers have a home range of 200 ha and a minimum critical patch area of 7,000 ha (see WMP-20570, the Phase I EcoDQO). Thus, badgers will integrate exposure over a large area and make it difficult to interpret the results in terms of the impacts of specific waste sites. It is agreed that mice represent a good middle trophic-level species to assess integration of contaminants within roughly 1 ha-sized areas across the site. A substantial database for small mammals exists from the Onsite Environmental Monitoring Program. Basic information pertaining to media, locations, analytes, and detection limits has been compiled and evaluated for the relevant studies to support the Phase II EcoDQO in direct response to this issue. Because of their lesser site fidelity and greater vagility, interpretation of results is more problematic for birds. Evaluation of ground-nesting and shrub-nesting birds is included in Phase I of the Central Plateau investigations.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
7	Are pheasants present in the Central Plateau? They may represent a bird species with a smaller home range. (JP)	N	Pheasants generally do not exist on the plateau because of the absence of surface water. They still are found along the river, but the populations have dwindled significantly since Hanford Site operations ceased, and they are not a good species for sampling.
8	Selection of the reference areas is important. Consider use of a transect to identify a reference area. For example, a transect drawn from 200 East Area, across the 200 West Area and continuing westward, goes through the McWhorter Ranch and into the Yakima Training Center. Both of these non-Hanford sites could be considered for use as reference areas. These areas would need to be verified as suitable, based on terrain and habitat similarity. However, because of its rough terrain, the McWhorter Ranch may not be a good fit. (JP)	Y	Two reference areas have been identified for sampling, one for Phase I (see DOE/RL-2004-42,the Phase I EcoSAP), and one for Phase II. In the event that additional or alternate reference areas are needed, the suggested transect will be considered as a means of identifying reference areas.
9	Three lines of evidence are associated with the special-status species, including observation, uptake modeling, and measured body tissue concentrations. 1. **Observation** – How are the special-status species faring compared to the reference sites? 2. **Modeling** – Model the uptake by the special-status species. 3. **Measure Body Tissue Concentrations** – Body tissue concentrations should be determined from the surrogate species both to support modeling for the special-status species and as an analog for concentrations in the special-status species. (JP)	Y	Agree. The approach for dealing with the special-status species that was developed for WMP-23141, the 100-NR-2 EcoDQO, will be adopted in the Central Plateau EcoDQOs, but may be deferred to Phase III, depending on schedule constraints. In the event that special-status species are identified in an investigation area, notes on the species and number of organisms will be recorded. Surveys for T/E species are required as part of the reconnaissance planning for site characterization work. As discussed in WMP-20570 (Phase I EcoDQO) and DOE/RL-2004-42 (Phase I EcoSAP), collection and analysis of contaminants in tissues of representative species will allow for concentration information, and modeling exercises will allow for dose estimates to special-status species identified as assessment endpoints.
GENERAL COMMENTS, PARTICIPANT WORKSHOP FOR PHASE II ECODQO, 3 FEBRUARY 2005			
10	For the BC Controlled Area, the BC Cribs and Trenches are the source of contamination. It is proposed to sample the cribs and trenches as part of the characterization for this area	N	The 216-B-26 and 216-B-58 Trenches were characterized as part of the human health risk assessment for the Central Plateau. The data from those characterizations provided the initial indication that the contamination in the BC Controlled Area might be limited to radiological constituents, which was verified through the BC Controlled Area soil characterization performed in March 2005.
11	For the US Ecology site, concern was raised about swallows inhabiting the freshly exposed trench walls.	Y	Construction activities and other forms of human disturbance limit bird activity; wastes are buried immediately (daily), so exposure should be minimal. It also was noted that there have been no documented releases from the trenches; and an active monitoring program includes continuous air monitors that alert the operators with an alarm in the event of a radiation release.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
12	For the tank farms, the issue was raised of herbicide and pesticide overspraying on Office of River Protection property.	Y	Tank Farms most appropriately would be assessed in Phase III with regard to how these practices could affect biota in Central Plateau habitat.
13	The tank farms were presented as ecological sinks, but it was noted that consideration of the sites in this light should be tempered with the recognition that animals can and do move in and out of the sites.	Y	Agree. Currently, Duratek Federal Services of Hanford, Inc., is trapping animals (primarily rodents) and performing radiation surveys of captured animals; noncontaminated animals are released at some point distant from tank farm sites.
14	There are few attractive nuisances on tank farm sites to exacerbate animal immigration and emigration (e.g., all water supplies being eliminated), but some releases would represent a sodium-rich environment that potentially could attract animals.	Y	Agree. However, the Hanford Site has ceased production operations. A significant portion of the releases were deliberate below-ground discharges. Surficial liquid discharge waste sites like ditches and ponds have been covered with stabilizing fill soil. As surface contamination is discovered, it is promptly removed/stabilized.
15	While recognizing that sampling the tank farms under current conditions is inappropriate, a request was made to use all applicable aspects of the current risk assessment activities for evaluating the tank farms. For example, COPECs and exposure pathways might be assessed now rather than waiting 20 years to get under way.	--	It is noted that the current EcoDQO framework would serve as the basis for evaluating risk to tank farm ecological receptors. Also, activities presently are under way to assess biota risks using RESRAD-BIOTA (DOE/EH-0676), based on a unit dose for the top 4.6 m (15 ft) that can be updated as more specific concentration data become available for Office of River Protection sites.
16	The number of investigation areas was discussed, particularly the suitability of having 6 waste sites in Phase I represent all (500 plus) Central Plateau waste sites.	Y	Criteria that went into waste site selection in Phase I were reiterated. For example, in contrast to high-risk sites that already were planned for remediation because of human health concerns, sites were selected where ecological risks could make a difference in site management. High-risk sites are less appropriate for ecological sampling, based on the depth of cover and plant/animal mitigation efforts at these sites. Because participants recognized that the waste-site selection process was comprehensive and defensible, the issue was more along the lines of making sure that the process and selection logic were transparent. Participants were directed to the waste-site selection process used in Phase I and included in the executive summary (see Chapter 9.0 of WMP-20570).
17	A concern was raised over evaluating inhalation risks. Specifically, it was noted that because volatiles will not be sampled in Phase I or Phase II sites, volatiles clearly would not be identified as risk drivers.	Y	It was clarified that risks to fossorial mammals inhaling volatiles (notably carbon tetrachloride) in their burrows would be a component of Phase III.
18	The comment was made that assessment endpoints and receptors were being used interchangeably and that the participants would benefit from having the difference highlighted between receptors and assessment endpoints.	Y	Central Plateau EcoDQO documentation has been revised for consistency and to clarify the difference between receptor as an entity and assessment endpoint as an attribute of the entity that will be measured.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
19	Regarding measurement endpoints, what if you don't get enough animals? In other words, what's Plan B?	Y	This ecological risk assessment is evaluating a variety of measures for all categories. Considering the upper trophic level, for example, the EcoDQO is looking more at calculations of exposure than at empirical measures. Middle trophic-level species, on the other hand, are more widely abundant and more amenable to empirical data collection; for example, body burden data on deer mice can be used for projecting a COPEC dose to upper trophic levels. A pilot study on shrub- and ground nesting birds is proposed to assess whether nesting birds are abundant. It is realized, of course, that the EcoDQO involves data collection for many measures. Considering that not all measures may be practical enough to collect -- in getting enough reproductively active ground-nesting birds to measure, for example -- it is important to propose many lines of evidence. The consideration of potential measures is an exercise grounded in Hanford Site experience; specifically, the measures are consistent with what Ron Mitchell (Duratek) considers possible from a field collection standpoint.
20	Questions about upper trophic receptors like the badger were raised; for example, regarding how they would be collected.	--	It was clarified that there are no plans to collect badgers. Rather, inferences can be made on what badgers eat and, knowing that the diet is 80% pocket mice and having empirical COPEC data for mice, a dose to badger can be calculated.
21	How would something like S-V length for lizards from one site provide an inference for S-V length at other sites?	Y	It was noted that variability in something like S-V length is expected, and it may be difficult to make inferences between and among investigation areas for this parameter. But the EcoDQO is using a weight-of-evidence approach and trying to evaluate each risk question with independent measures and, hopefully, more than one measure.
22	Can lizards really be used for relative density measures?	Y	Yes, if the measure is a qualitative assessment based on opportunistic or other (e.g., pitfall) collection.
23	Considering COPECs in biotic tissues, why not measure plants?	N	The reason is that COPECs should show up in invertebrates first. Plant tissue concentrations (Tier 2 data) will be assessed if radiation surveys on plants (Tier 1 data) warrant Tier 2 plant data collection (in Phase III).
24	Questions were raised about COPEC uptake factors (e.g., bioaccumulation factor) based on soil/biota data. For example, "are uptake factors all collected together in one place for the Hanford Site?"	Y	The information is not consolidated as yet but, by making these data compatible with historical data collection activities, the activity should result in a robust Hanford Site-specific data set. It was noted that for human pathways, the soil-to-plant uptake factor is really generic, and the suggestion was made to revisit it. This project will provide site-specific uptake in Tier II data.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
25	What was the basis for not collecting at depths of 0-15 cm and 15-30 cm (0-6 in. and 6-12 in.)?	Y	The two intervals initially considered are now limited to the first 15 cm (6 in.), because it is difficult to keep the deeper half discreet from the first interval. Using the 0-15 cm (0-6-in.) interval also is consistent with previous ecological sampling data and increases the comparability with existing data.
26	Considering reference areas, a concern was raised about having a reference site within an area that potentially has been impacted. Participants were not convinced that reference sites close to the Central Plateau waste sites are valid. In reference to aquatic systems, it was noted that it is typical to go upstream for reference locations; for terrestrial systems, however, there is no upwind location - wind roses show winds in all directions. Questions also were brought up over the plan to use a gradient.	Y	In response, it was noted that the reference site considered is upwind from the direction of the prevailing winds, in an effort to balance the most comparable habitat with potential for impacts from Hanford Site operations. In response to the gradient concern (i.e., whether the assessment would normalize waste site concentrations to a toxicity reference value or normalize to a reference site), it was noted that the gradient will be one pooled from the list of waste sites rather than a geographic gradient and that all investigation areas (n=11) would be ranked, allowing one to get a dose response. It is important to note that some measures will show less variability in response to a gradient than will others. For example, things like biotic uptake should show low variability between COPEC gradient and uptake versus, say, abundance and a COPEC gradient. Data comparisons will involve reference sites versus waste sites and will involve comparisons based on gradient. If a gradient is not feasible, it is possible that we may end up using areas of "high" and "low" concentrations.
27	The issue of past practices and PCBs was addressed. It was noted that PCBs were used for dust control on roads but that records (it was suggested that maintenance had most records) are lacking for which roads received PCBs, and few samples were taken to characterize PCBs in the environment. Past proposals to study PCBs on roads were submitted, but these never were funded.	Y	Phase I has a PCB sampling site location along the side of the road.
28	In a discussion involved waste site selection, it was noted that sites without vegetation did not get selected. Participants asked, "Why collect any data in a denuded waste site?" It was suggested to assume that the site is 100% injured and take a look at it at an appropriate later date.	Y	An action item is to take this issue to DOE's Jamie Zeisloft.
29	Participants questioned the site management goals; for example, with regard to studying waste sites where deep-rooted plants are discouraged by herbicide application, are we just evaluating herbicide-tolerant organisms? What is the null hypothesis that is being tested?	Y	In response, abiotic and biotic data are being collected in multiple lines of evidence; this assessment is not set up as a simple statistical (e.g., t-test) comparison. Also, the confounding factor of herbicides is the same for all waste sites.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
30	There was confusion about how the data collected will be used in decision making; for example, is a threshold like a lowest observed adverse-effect level (LOAEL) being calculated?	Y	It was clarified that the goal of the assessment was to provide decision makers with the risk information they need to address risk-management concerns. Thresholds like LOAELs may be calculated (with Tier 2 data), and it will be the risk manager's decision as to how this information will be used.
31	Considering West Lake, which existed before Hanford Site operations began (e.g., evidence of a stage coach location in the past) but was greatly expanded because of water releases, it was noted that in addition to PUREX releases, the lake originally was contaminated with B Plant releases. It was also clarified that there was not a direct connection between Hanford Site operations and West Lake. The lake increased in size because the water table was raised. In response to observations of the lake being no more than 3 m^2 in October 2004, it was remarked that the current area is around 200 m^2. It was recognized that West Lake is dynamic and responds to climatological/seasonal conditions such as spring snow melt.	Y	West Lake will be considered for assessment under Phase III of the Central Plateau EcoDQO. The current activities for West Lake are to compile all of the existing monitoring and surveillance information and use this information in future plans or assessments.
32	The salts found around West Lake were speculated to be resulting both directly from natural conditions and indirectly from Hanford Site operations. It was suggested that if salts are exerting adverse effects, one could try and remove the salts only, although it was unclear if this area would just become salty again if groundwater was the source of the salts. This generated discussion over whether the soils or groundwater was the source of potential contamination. Possible remedial alternatives were considered. For example, if groundwater were the contamination source, the lake would not be expected to be clean until groundwater is remediated.	Y	Receptors could be excluded from the lake bed with rip-rap, but this would incur mitigation costs associated with loss of wetlands; clearly there is no obvious preferred remedy at this point in time. It is useful at this point, however, to consider separate DQO activities for West Lake to determine how ecological risk or human health risk results could be used to determine the optimal remedy.
33	It was asked if the groundwater would ever be remediated, noting again that West Lake could not be remediated until after groundwater had been remediated. When is 200 Areas groundwater going to be cleaned up? Questions also were raised over current efforts to assess West Lake.	Y	In response, this was recognized as the most difficult problem that the Tri-Parties currently face. In reference to groundwater and West Lake, it was unclear if the aquifer is currently perched (and separate from other groundwater influence) or if it is still connected. It was noted that risk assessors are working with other organizations for any West Lake information and they will review existing reference materials.

Table A-1. Participant Interview Issues Matrix. (8 Pages)

#	Interview Issues	Accept?	Comment Resolution
34	Concern was expressed over the uncertainty of the Phase III design, but the participants were assured that they would have the opportunity to comment on the data assessment and Phase III design.	Y	It was clarified that Phase III includes the planning for habitat sampling and that there are no specific commitments for Phase III data collection. It also was explained that some ecological data exist for the Central Plateau habitat areas, and these existing data were illustrated with the example of the existing small mammal tissue contaminant data. These data will be considered in Phase III. On 11/16/05, a commitment was made to the Trustees that the Phase III EcoDQO workshop scheduled for late February 2006 would be a two-day session to allow for evaluation of the Phase I and Phase II ecological data and associated impacts on Central Plateau ecological characterization requirements.

Key to Entries in "Accept" Column:

Dash (-)= In some cases, the dash means that clarification is needed. In other cases, the issues were considered to be tangential and may not affect the outcome of the DQO. Nevertheless, they were considered important and answers were provided.

N = No

Y = Yes

Initials of Paraticipants:

CC = Craig Cameron
DF = Dennis Faulk
DS = Don Steffeck
FA = Frank Anderson
JP= John Price
LG = Larry Gadbois
TK = Tony Knepp

BHI-01319, *Data Assessment Report for the Sampling and Analysis Activities Conducted to Support Reposting the 200 B/C Contaminated Area.*

D&D-24693, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization.*

DOE/EH-0676, *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation*, User's Guide, Version 1.

DOE/RL-2004-42, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I.*

DOE/RL-2005-37, *Status of Hanford Site Risk Assessment Integration, FY 2005.*

WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, in preparation.

WMP-23141, *100-NR-2 Groundwater Operable Unit Ecological Risk Assessment Data Quality Objectives Summary Report.*

COPEC = contaminant of potential ecological concern.
DOE = U.S. Department of Energy.
DQO = data quality objective.
EcoDQO = ecological data quality objectives.
EcoSAP = ecological sampling and analysis plan.
ERAGS = ecological risk assessment guidance for superfund
LOAEL = lowest observed adverse-effect level.
ORP = Office of River Protection.
PCB = polychlorinated biphenyl.
PUREX = Plutonium-Uranium Extraction Plant.
ROD = record of decision.
S-V = snout vent (length)
T/E = threatened and/or endangered
Tri-Parties = Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy.

2.0 REFERENCES

BHI-01319, 1999, *Data Assessment Report for the Sampling and Analysis Activities Conducted to Support Reposting the 200 B/C Contaminated Area*, Decisional Draft, Bechtel Hanford, Inc., Richland, Washington.

D&D-24693, 2005, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

DOE/EH-0676, 2004, *RESRAD-BIOTA: A Tool for Implementing a Graded Approach to Biota Dose Evaluation*, User's Guide, Version 1, ISCORS Technical Report 2004-02, Interagency Steering Committee on Radiation Standards, U.S. Department of Energy, Washington, D.C.

DOE/RL-2004-42, 2005, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2005-37, 2005, *Status of Hanford Site Risk Assessment Integration, FY 2005*, Rev 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WMP-20570, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, in preparation, Fluor Hanford, Inc., Richland, Washington.

WMP-23141, 2005, *100-NR-2 Groundwater Operable Unit Ecological Risk Assessment Data Quality Objectives Summary Report*, in preparation, Fluor Hanford, Inc., Richland, Washington.

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APPENDIX B

CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN REFINEMENT: NONRADIONUCLIDE DATA

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APPENDIX B

CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN REFINEMENT: NONRADIONUCLIDE DATA

1.0 INTRODUCTION

The Phase II nonradionuclide contaminants of potential ecological concern (COPEC) were based on a characterization activity that analyzed BC Controlled Area soils for metals, total uranium, anions, and Aroclors[1] under the 200-UR-1 Operable Unit remedial investigation (D&D-24693, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*). Samples were collected from the most highly contaminated locations and from moderately contaminated locations in the BC Controlled Area; specifically, Zone A hotspots, as well as randomly selected locations in Zones A and B. This activity was based on the assumption that nonradionuclides coincide with the radionuclides, because the contamination was deposited solely by animal excretion. Nonradionuclide analyses on these samples included the same nonradionuclide suites (excepting pesticides) identified in WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, and DOE-RL-2004-42, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I.*

Sixteen samples from Zones A and B were analyzed. *Washington Administrative Code* soil-screening values (WAC 173-340-900, "Tables," Table 749-3) and Hanford Site background soil concentrations (90th percentile values from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*) lead to a comparison value for the maximum detected concentrations of each analyte. Detected values less than the comparison value are eliminated as COPECs. Analytes that are all non-detects are not compared to background or carried through evaluation. WAC 173-340-900 employs toxicity reference values based on lowest observed adverse-effect levels (WAC 173-340-900, Table 749-5) and plant/soil biota soil-screening values based on lowest observed-effect concentrations (WAC 173-340-900, Table 749-3).

Aroclors were eliminated as COPECs, because they were not detected (detection limits for Aroclors were less than the WAC 173-340-900, Table 749-3, total polychlorinated biphenyl soil-screening value). Inorganic analytes also were dropped from the initial COPEC list if they were within the range of background concentrations (DOE/RL-92-24) or were below applicable soil-screening values. Ecology 94-115, *Natural Background Soil Metals Concentrations in Washington State*, also was used for background concentrations (using 90th percentile values) where no site-specific background concentrations were available (e.g., cadmium). For the metals, none of the detected analytes exceeded background or WAC 173-340-900, Table 749-3 soil-screening values. These results are provided in this appendix. Consequently, no nonradionuclide COPECs are identified for Phase II.

[1] Aroclor is an expired trademark.

2.0 REFERENCES

D&D-24693, 2005, *Sampling and Analysis Instruction for BC Controlled Area Soil Characterization*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-42, 2005, *Central Plateau Terrestrial Ecological Sampling and Analysis Plan - Phase I*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology 94-115, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-900, "Tables," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WMP-20570, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, in preparation, Fluor Hanford, Inc., Richland, Washington.

Table B-1. Nonradionuclide Contaminants of Potential Ecological Concern Refinement. (2 Pages)

Suite	Analyte	Total Count	Detection Status						WAC Table 749-3 (mg/kg)	Background[a] (mg/kg)	Comparison Value[b] (mg/kg)
			Not Detected			Detected					
			Count	Minimum (mg/kg)	Maximum (mg/kg)	Count	Minimum (mg/kg)	Maximum (mg/kg)			
Aroclors[c]	Aroclor-1016	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1221	16	16	0.1	0.11				0.65	NA	0.65
Aroclors	Aroclor-1232	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1242	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1248	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1254	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1260	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1262	16	16	0.05	0.053				0.65	NA	0.65
Aroclors	Aroclor-1268	16	16	0.05	0.053				0.65	NA	0.65
Inorganics	Antimony	16	16	1	1.05				5	NA	5
Inorganics	Arsenic	16				16	0.881	2.98	7	6.47	7
Inorganics	Barium	16				16	66.2	108	102	132	132
Inorganics	Beryllium	16				16	0.216	0.34	10	1.51	10
Inorganics	Boron	16	16	2.49	2.59				0.5	NA	0.5
Inorganics	Cadmium	16	4	0.102	0.105	12	0.109	0.209	4	0.81	4
Inorganics	Chloride	16	15	2.55	2.6	1	3.12	3.12	NA	100	100
Inorganics	Chromium	16				16	5.46	8.42	42	18.5	18.5
Inorganics	Cobalt	16				16	5.86	10.1	20	15.7	20
Inorganics	Copper	16				16	8.37	13.7	50	22	50
Inorganics	Fluoride	16	16	1.13	1.15				200	2.81	200
Inorganics	Lead	16				16	3.5	5.22	50	10.2	50
Inorganics	Lithium	16				16	5	7.51	35	33.5	33.5
Inorganics	Manganese	16				16	312	434	1100	512	512
Inorganics	Mercury	16	15	0.1	0.105	1	0.106	0.106	0.1	0.33	0.33
Inorganics	Molybdenum	16	9	0.306	0.315	7	0.324	0.693	7	NA	2
Inorganics	Nickel	16				16	7.28	10.1	30	19.1	30
Inorganics	Selenium	16	16	0.4	0.42				0.3	NA	0.3
Inorganics	Silver	16	15	0.1	0.105	1	0.148	0.148	2	0.73	2
Inorganics	Sulfate	16	13	4.9	5	3	10.5	38	NA	237	237

Table B-1. Nonradionuclide Contaminants of Potential Ecological Concern Refinement. (2 Pages)

Suite	Analyte	Total Count	Detection Status						WAC Table 749-3 (mg/kg)	Background[a] (mg/kg)	Comparison Value[b] (mg/kg)
			Not Detected			Detected					
			Count	Minimum (mg/kg)	Maximum (mg/kg)	Count	Minimum (mg/kg)	Maximum (mg/kg)			
Inorganics	Thallium	16				16	0.079	0.372	1	NA	1
Inorganics	Tin	16	16	1	1.05		0	0	50	NA	50
Inorganics	Uranium	16				16	0.34	0.863	5	3.21	5
Inorganics	Vanadium	16				16	36.7	58.1	2	85.1	85.1
Inorganics	Zinc	16				16	34.1	45.9	86	67.8	67.8

Values highlighted in yellow represent statewide inorganic background concentrations for Washington (Ecology 94-115, *Natural Background Soil Metals Concentrations in Washington State*).

[a] Background for inorganics based on 90th percentile values obtained from DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, or from Ecology 94-115 (the latter employing Eastern Washington State values).

[b] Generally the greater of WAC 173-340-900, "Tables," Table 749-3 soil-screening values and background (Ecology 94-115) unless the soil-screening value is based on background.

[c] Aroclor is an expired trademark.

NA = not available.

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